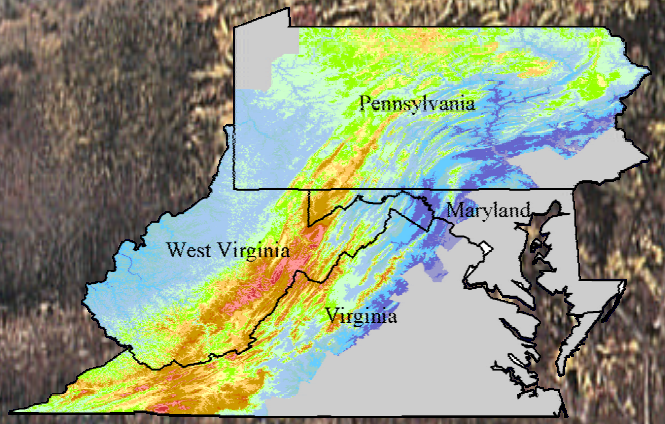
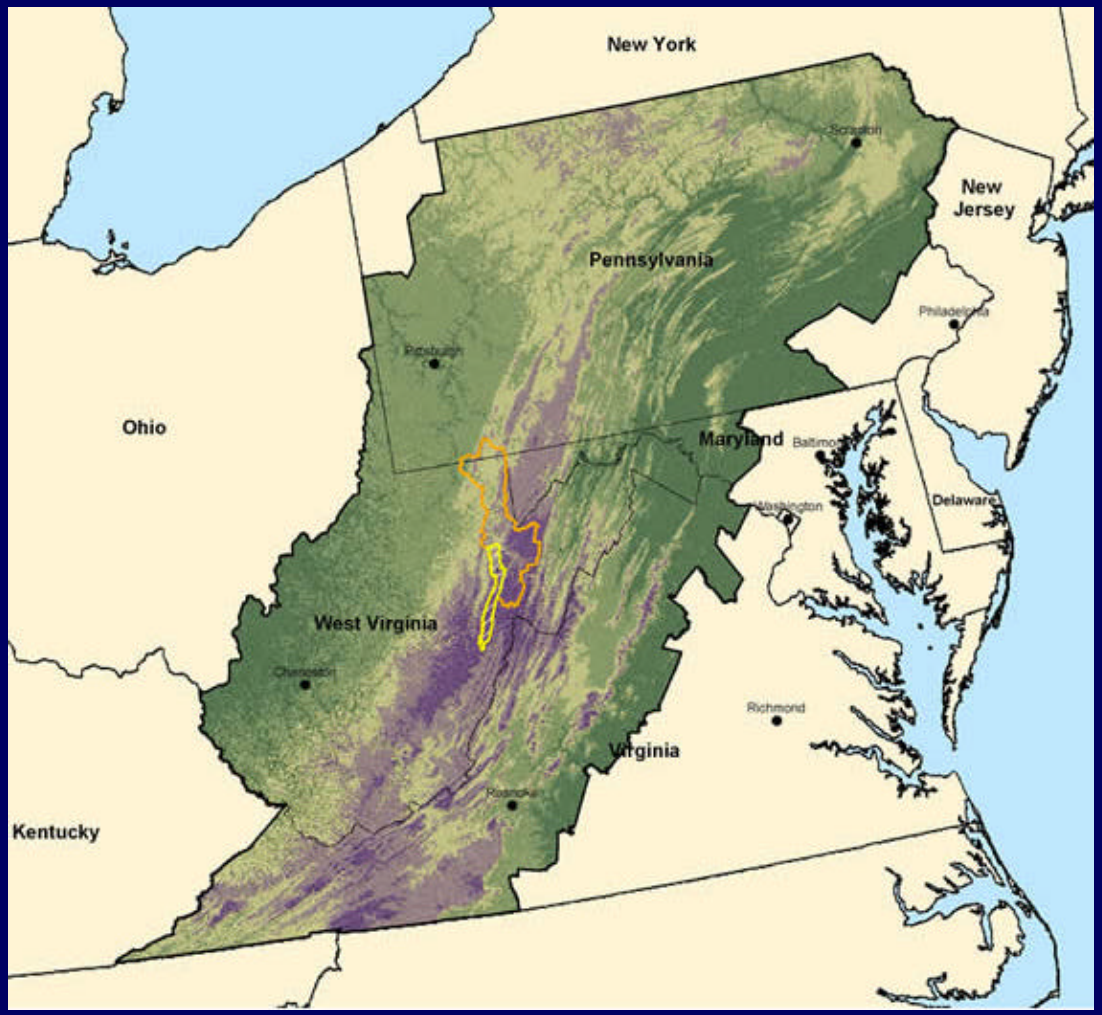
An Approach to Regional Ecosystem Protection: The Canaan Valley Institute Experience in the Mid Atlantic Highlands

Randy Pomponio
Canaan Valley Institute



Multiple Scales

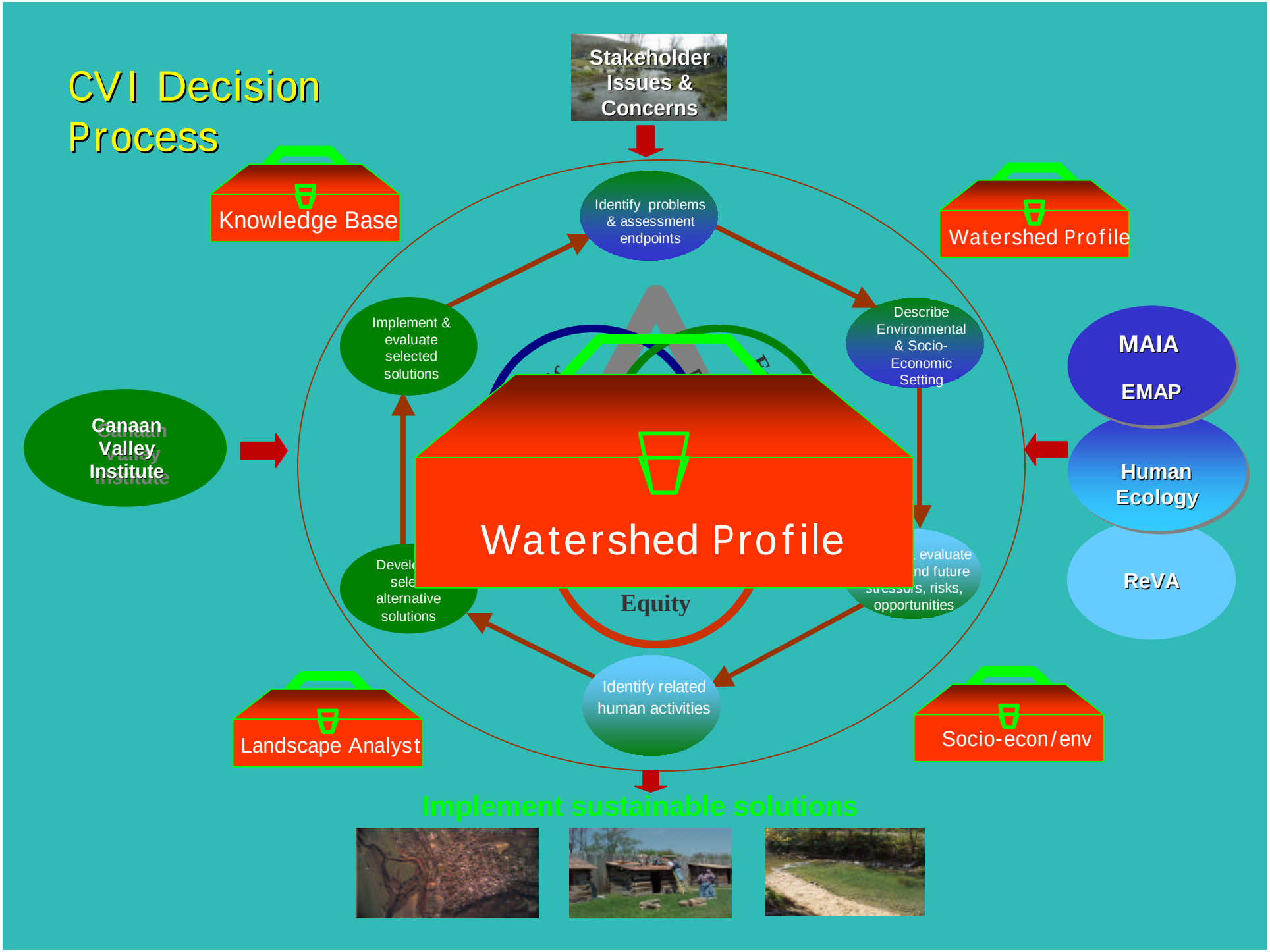


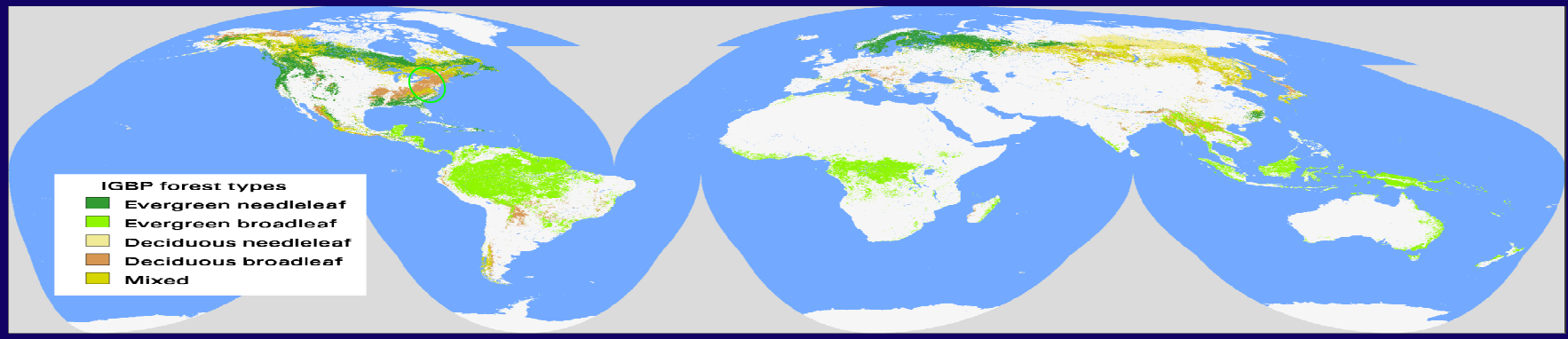
Mid Atlantic Highlands

West Virginia

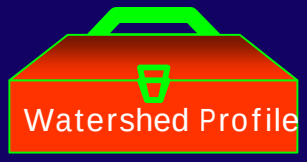
Cheat River Basin

Upper Shavers Fork Basin


CVI Decision Process
Stakeholder Issues & Concerns
Knowledge Base
Watershed Profile
Identify problems & assessment endpoints
Describe Environmental & Socio-Economic Setting
Implement & evaluate selected solutions
Canaan Valley Institute
MAIA
EMAP
Human Ecology
ReVA
Watershed Profile
Equity
alternative solutions
opportunities
Identify related human activities
Landscape Analyst
Socio-econ/env
Implement sustainable solutions

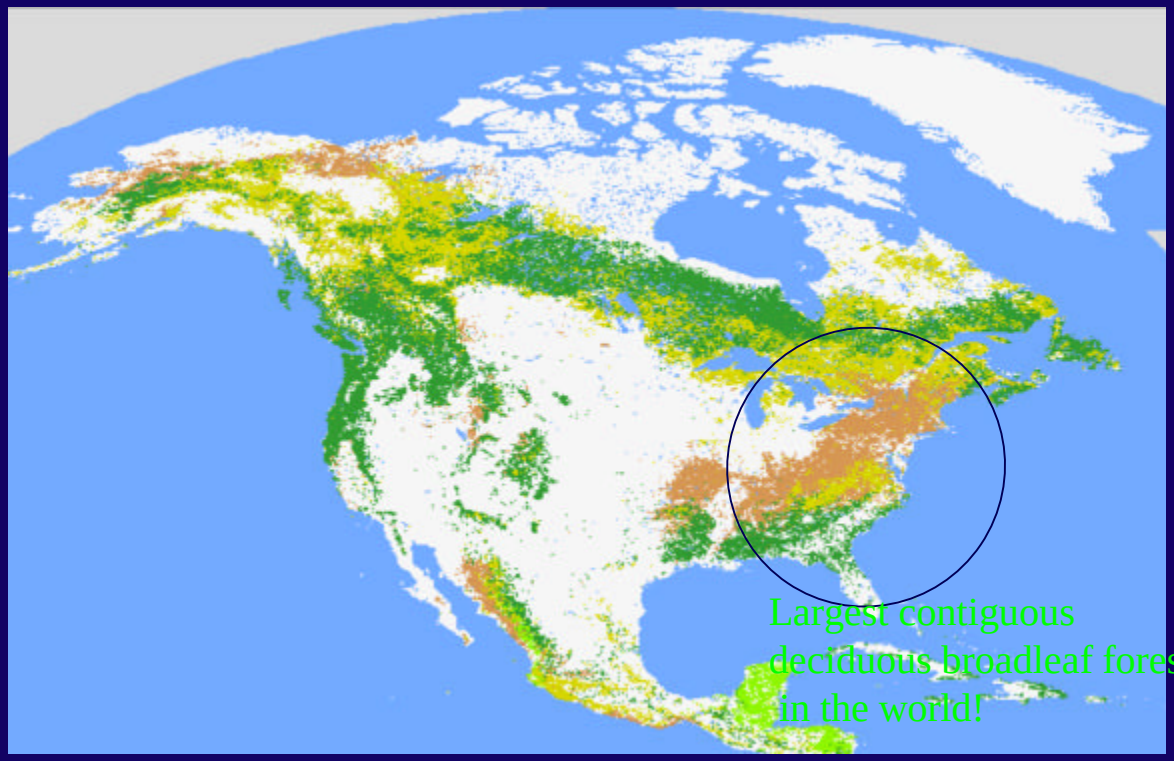


Global Ecological and Natural Resource Significance!



Identify problems & assessment endpoints

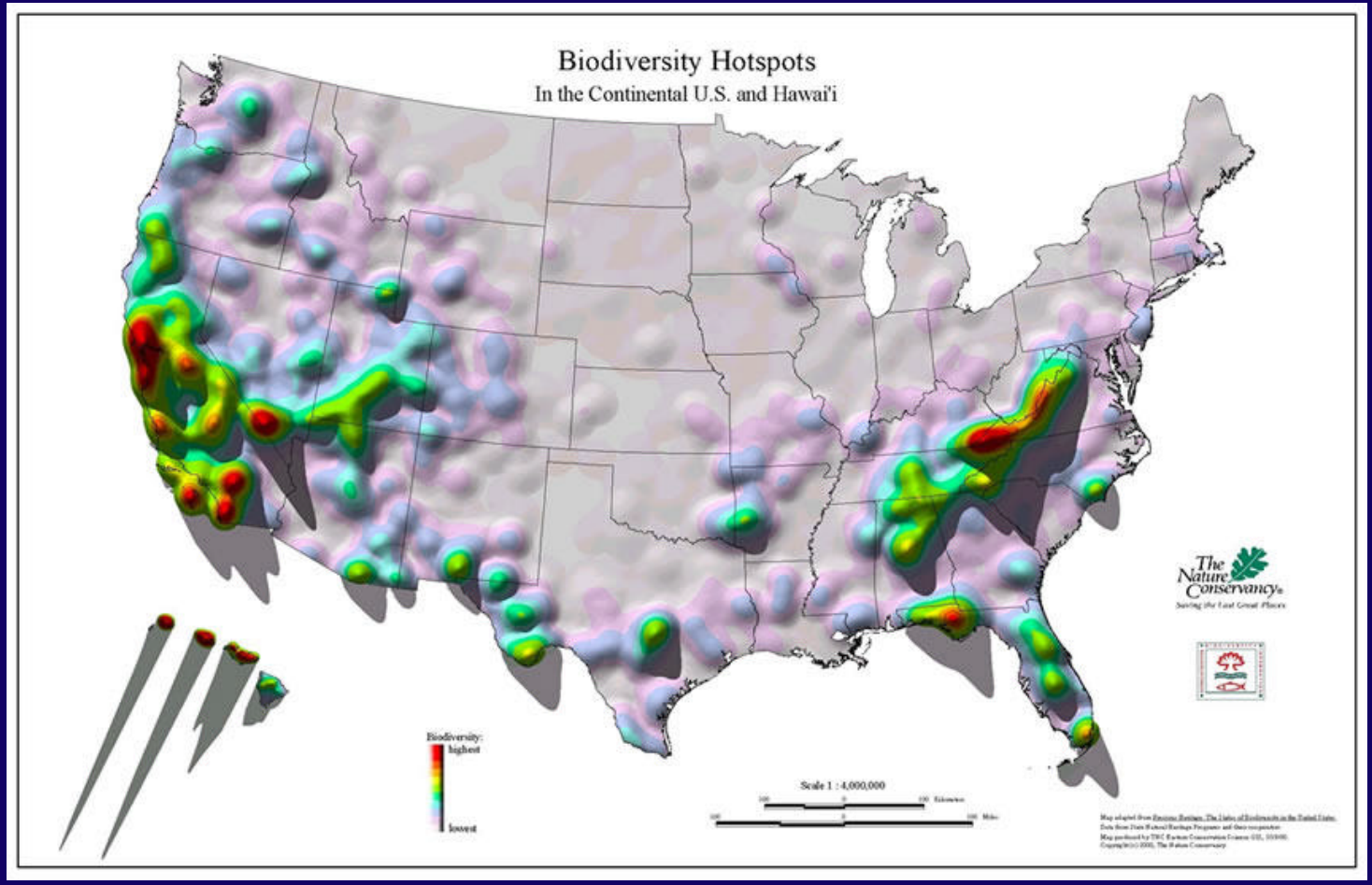
Describe Environmental & Socio-Economic Setting



Watershed Profile

Identify problems & assessment endpoints

Describe Environmental & Socio-Economic Setting



Threatened Streams and Habitat!

Watershed Profile

Identify problems & assessment endpoints

Describe Environmental & Socio-Economic Setting

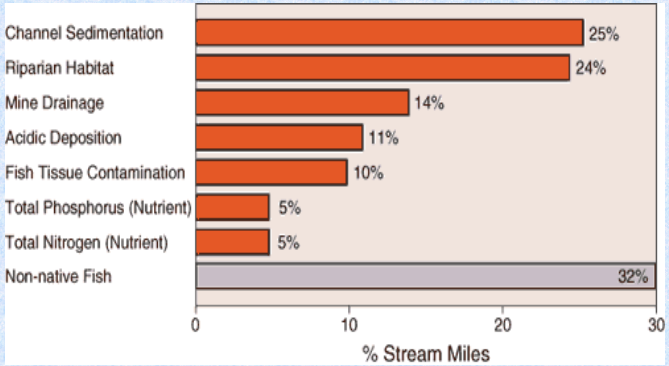
Identify & evaluate current and future stressors, risks, opportunities

THE MID-ATLANTIC INTEGRATED ASSESSMENT

Stream Condition

Biological Condition

Ranking of Stressors



CVI Decision Process

Knowledge Base

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Canaan Valley Institute

MAIA

EMAP

Human Ecology

ReVA

Socio-econ/env

Community Capacity

Social

Equity

Identify & evaluate current and future stressors, risks, opportunities

Develop & select alternative solutions

Identify related human activities

Landscape Analyst

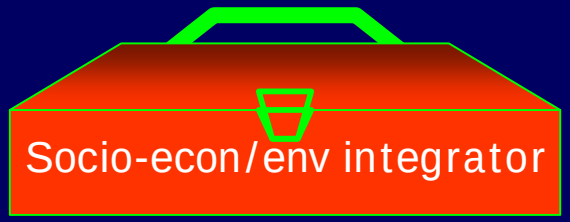
Socio-econ/env

Implement sustainable solutions

Defining the Science Agenda

We need a scientific foundation for the [holistic] integration of environmental and socioeconomic data and models in public policies…

Build



Approach: Energy Systems Analysis

- Emergy is the availability of energy of one kind that is used up in transformations directly and indirectly to make a product or service.

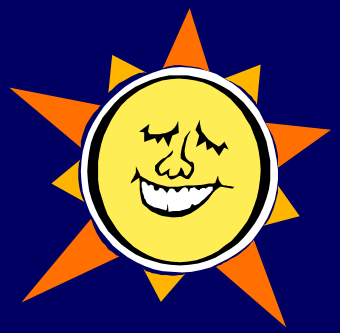
- Emergy of something is found by summing the inputs from the network of connecting inputs.

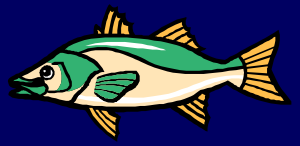
ENERGY: 1 kcal

180 kcal
(7.5×10^5 J)

1000kcal
(4.2×10^6 J)

120,000 kcal
(5×10^8 J)

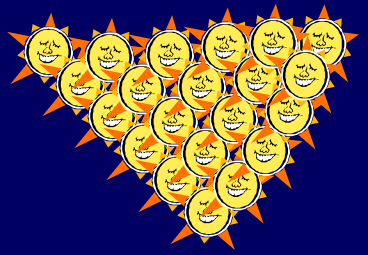


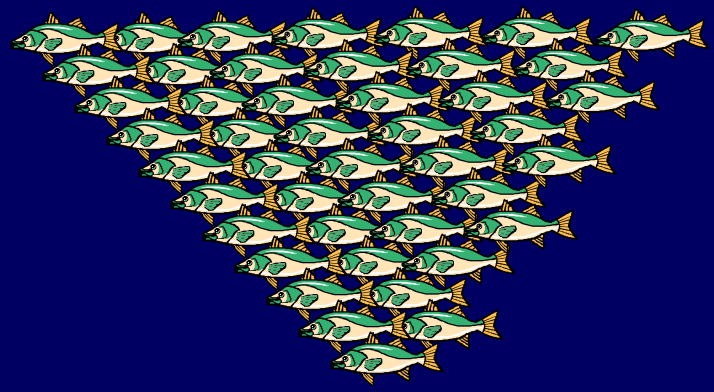


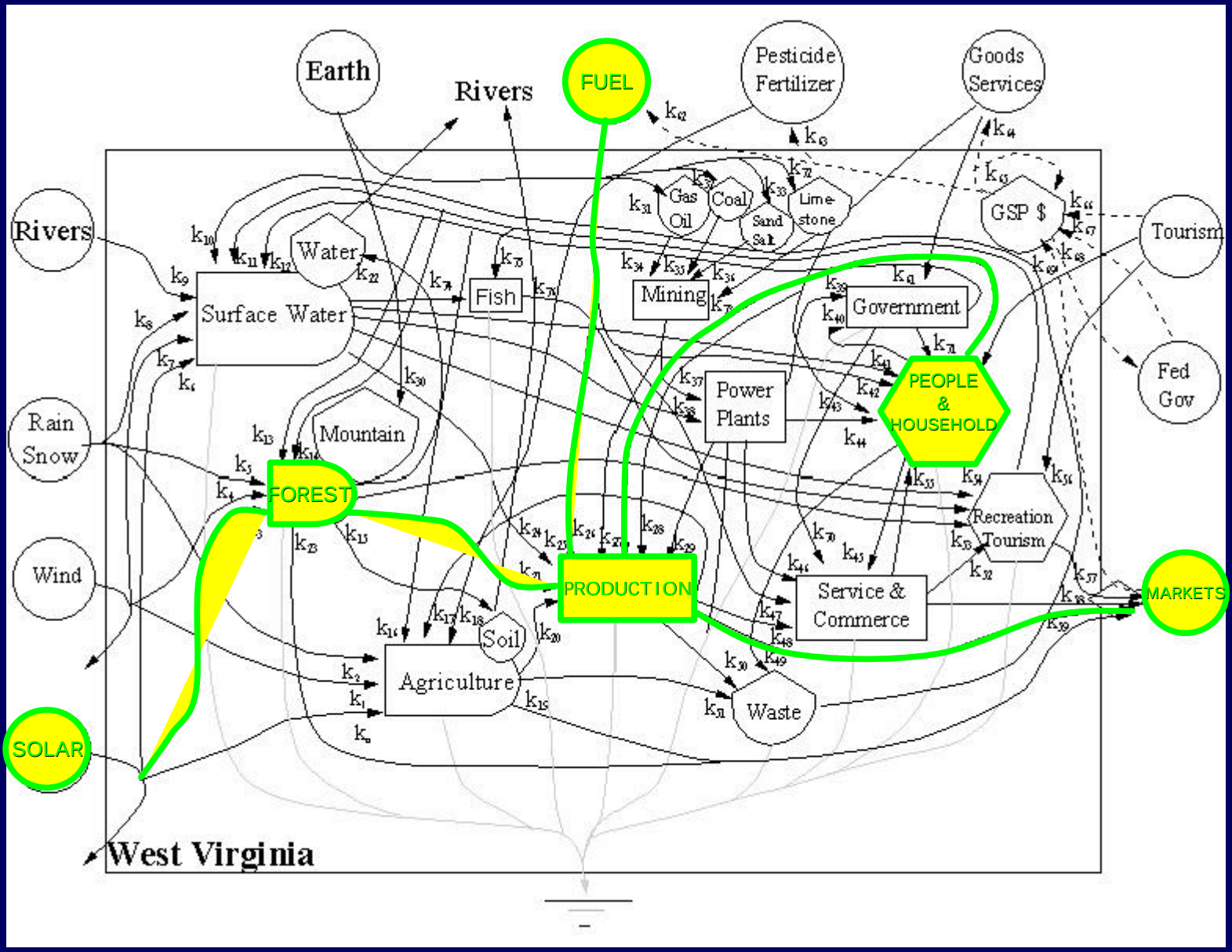
EmERGY:

225×10^7 seJ/yr

235×10^{10} seJ






Earth
Rivers
FUEL
Pesticide Fertilizer
Goods Services
Rivers
Water
Surface Water
Fish
Mining
Gas Oil
Coal
Sand Salt
Lime-stone
GSP $
Tourism
Government
Fed Gov
PEOPLE & HOUSEHOLD
Power Plants
Rain Snow
Mountain
FOREST
Recreation Tourism
Wind
PRODUCTION
Service & Commerce
MARKETS
Soil
Agriculture
Waste
SOLAR
West Virginia

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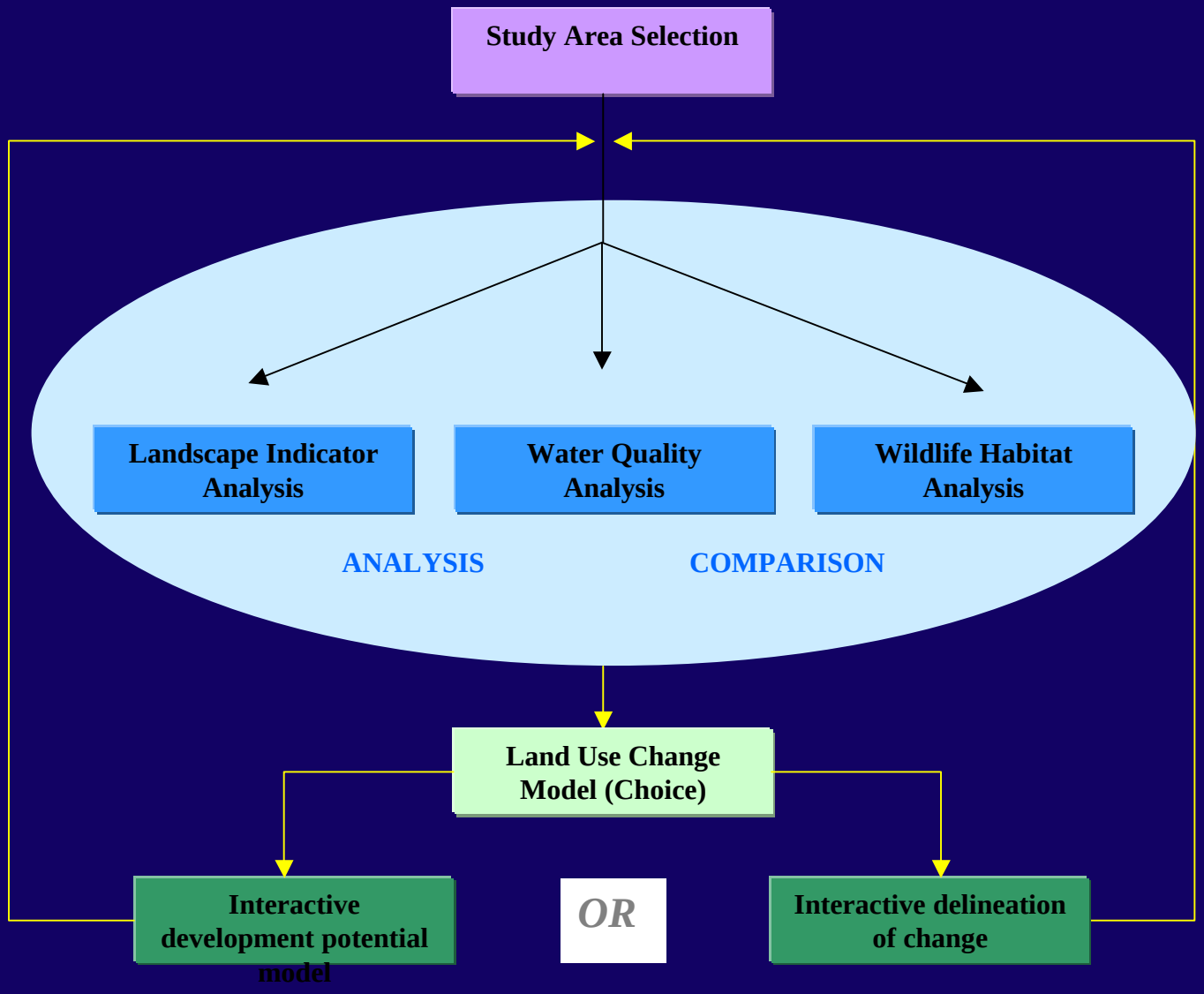
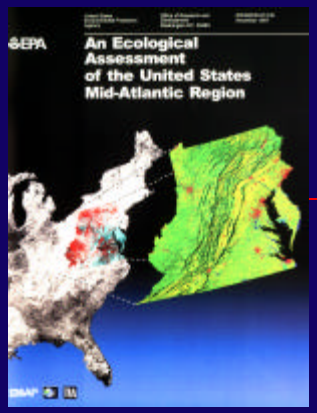
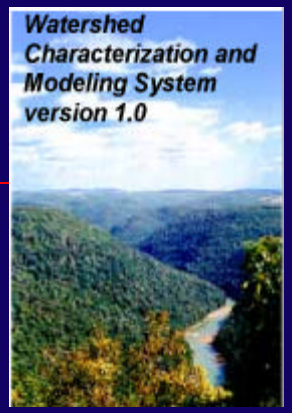


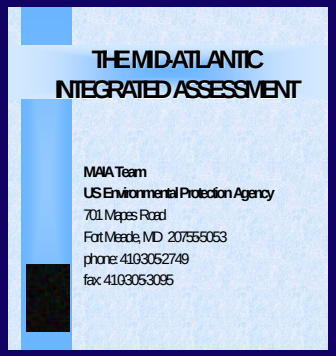
Primary Analytical Tools

US EPA Office of Research and Development's Ecological Assessment of Mid-Atlantic Approach



West Virginia University's Watershed Characterization and Modeling System

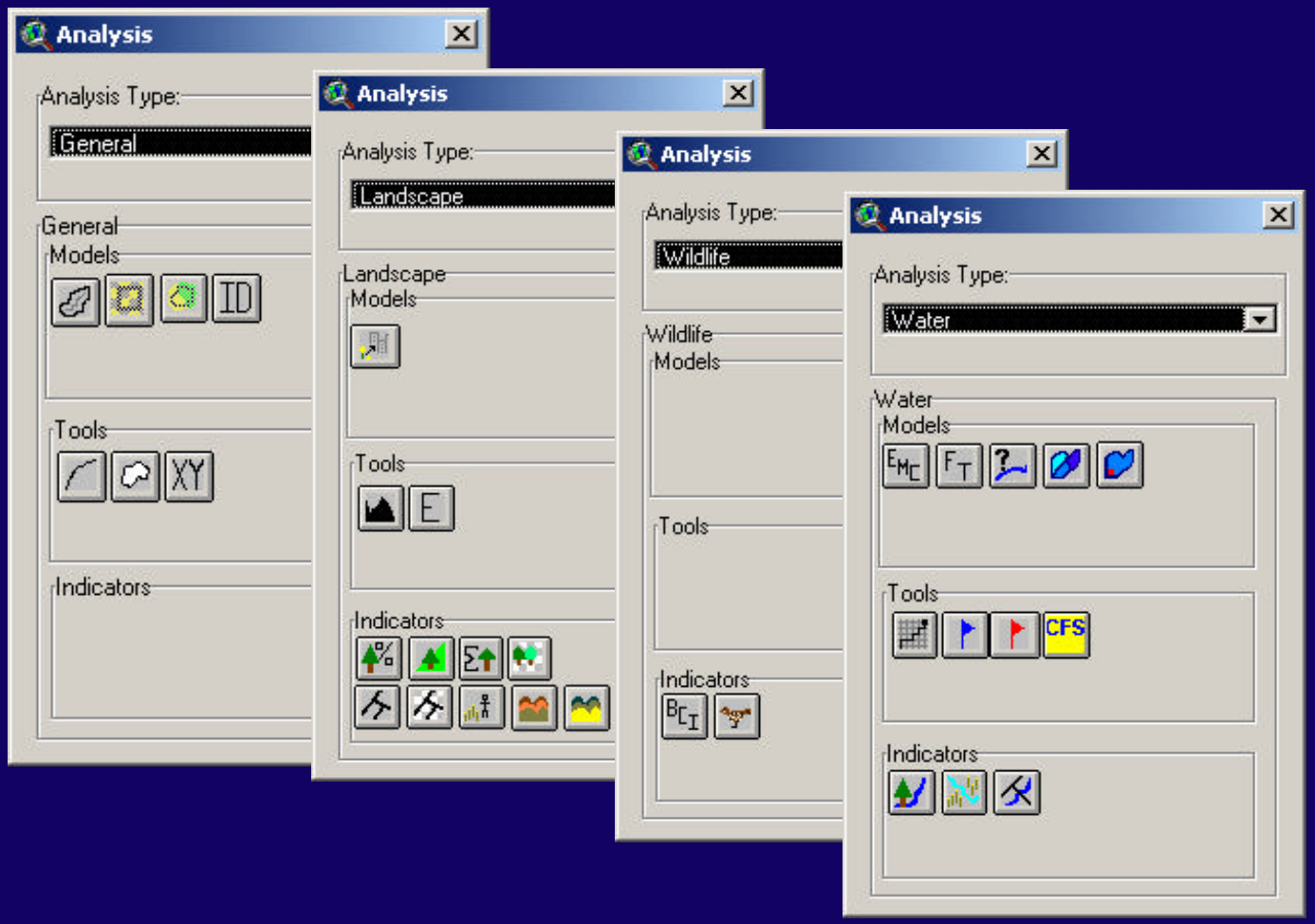




EPA's Mid Atlantic Integrated Assessment

Penn State University's Cooperative Wetlands Research Center

Landscape Analyst Models,Tools, Indicators



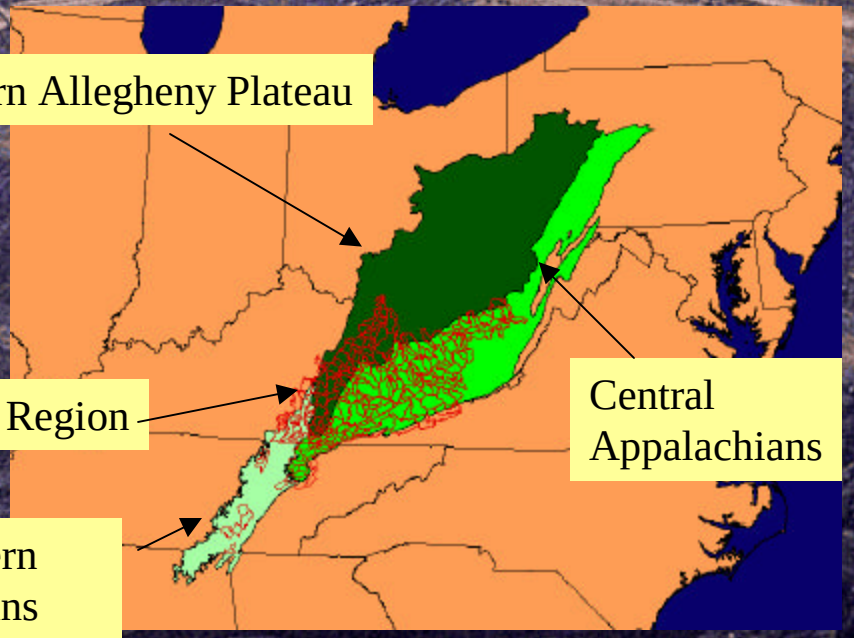
Case Example 1 : Mountain Top Mining

Landscape Analyst

Describe Environmental & Socio-Economic Setting

Identify & evaluate current and future stressors, risks, opportunities

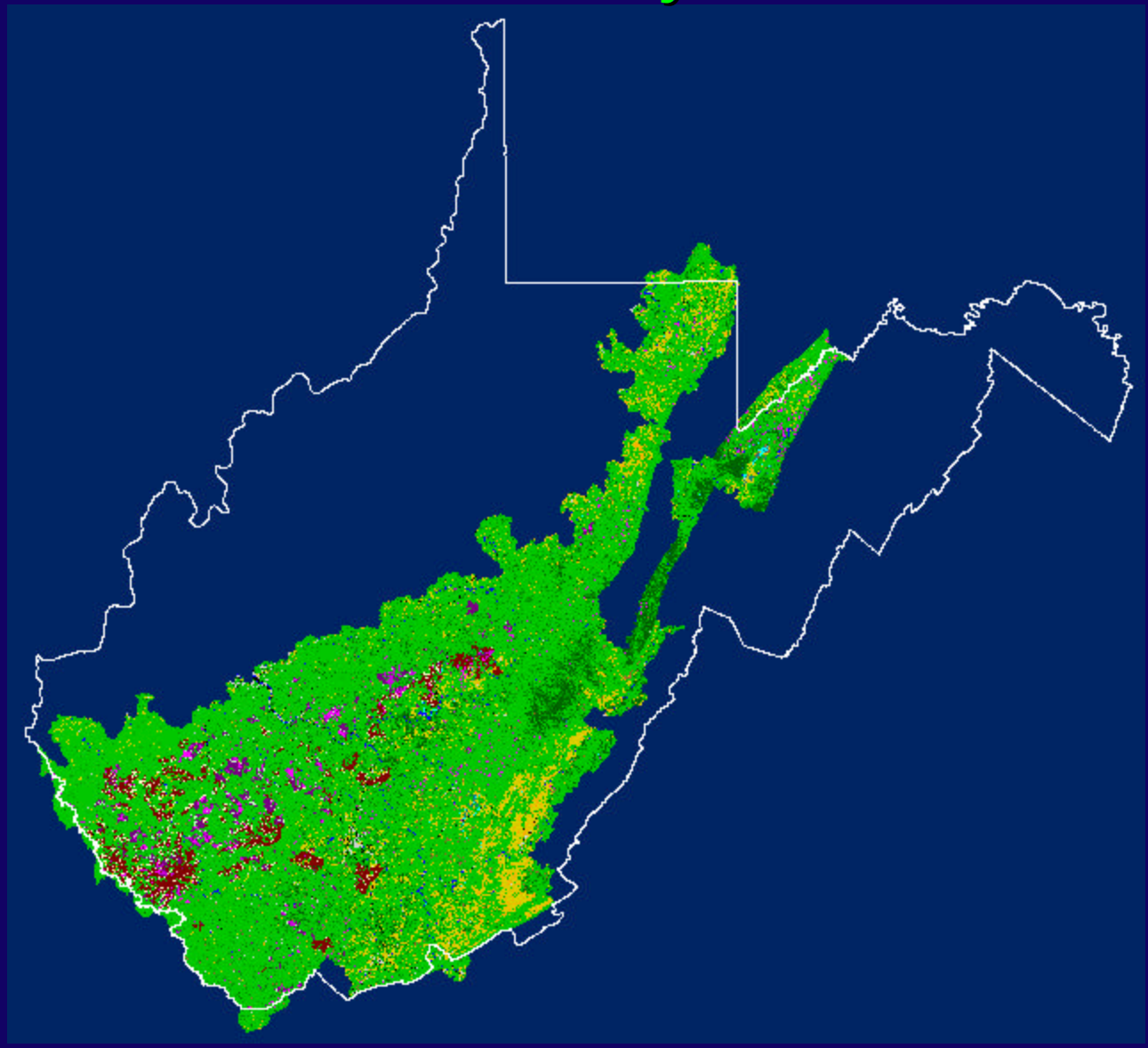
Develop & select alternative solutions



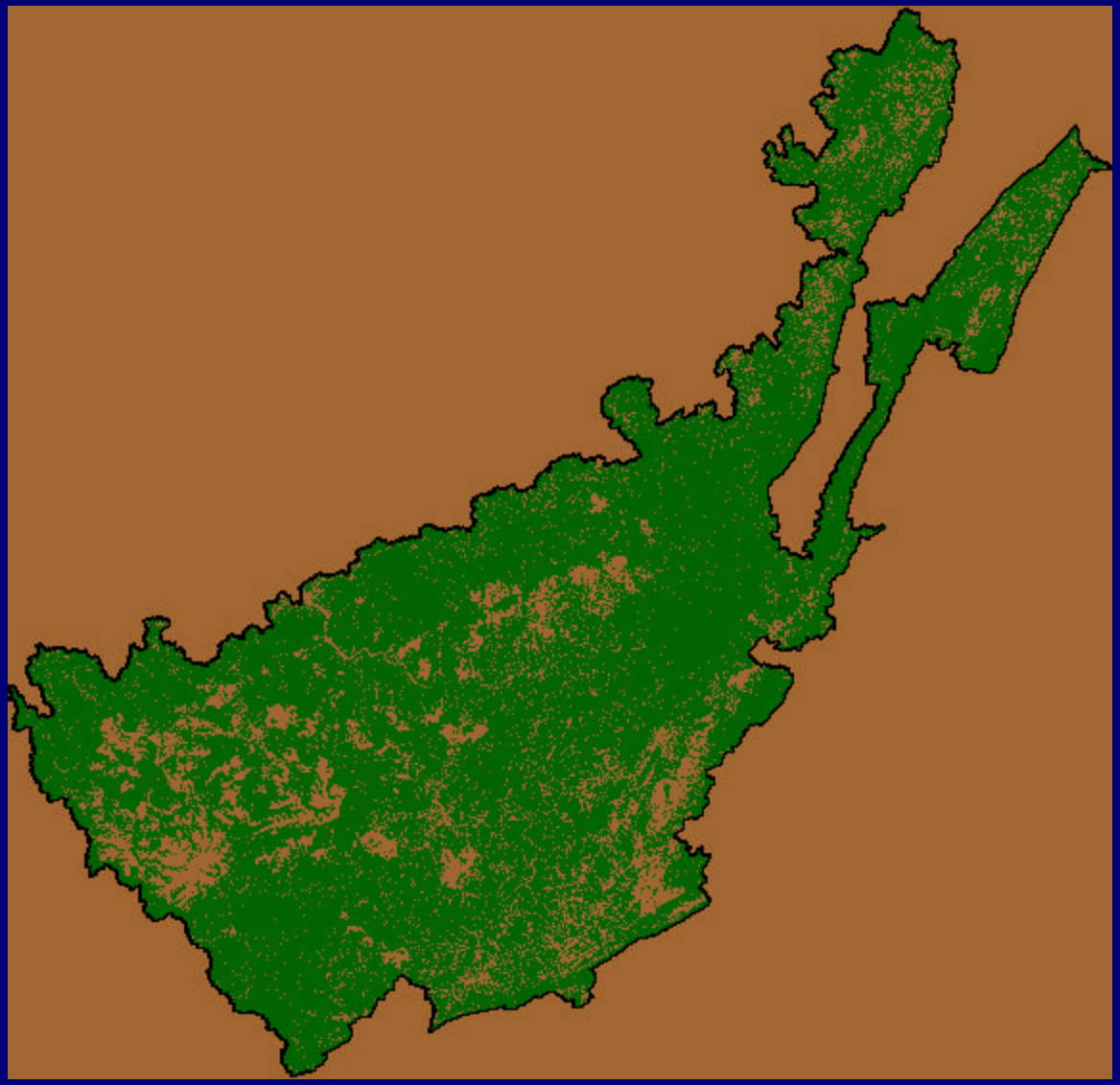
Case example-Mining in the Highlands

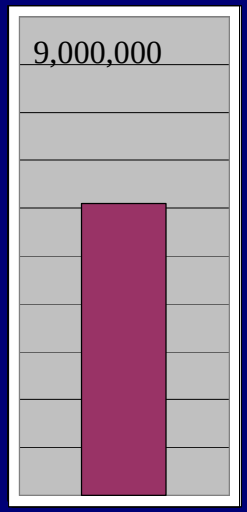
Identify site and issue specific social, economic, and ecological endpoints

Draft PEIS Study Area



Forest Change 1915 - Future

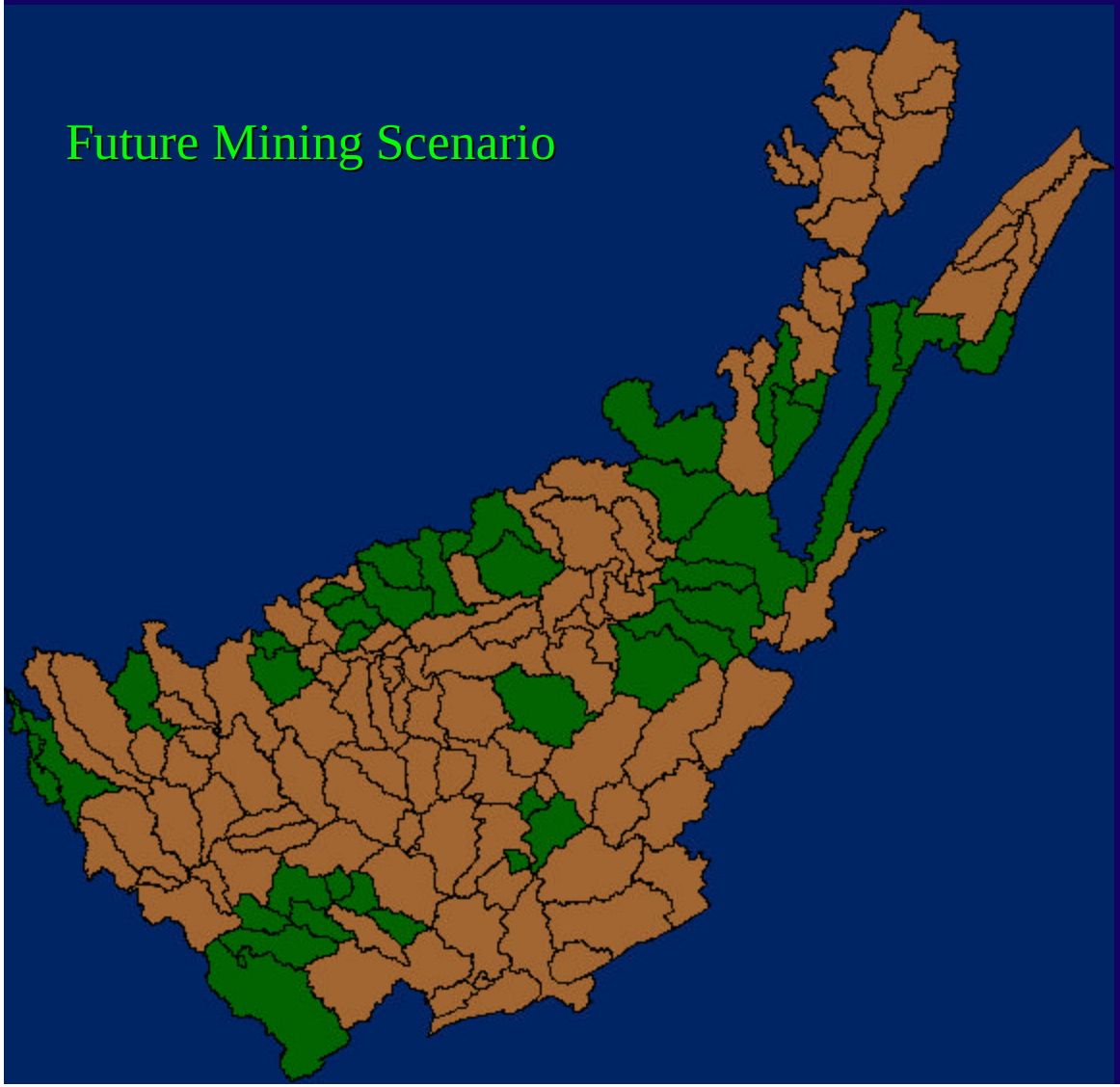




Future

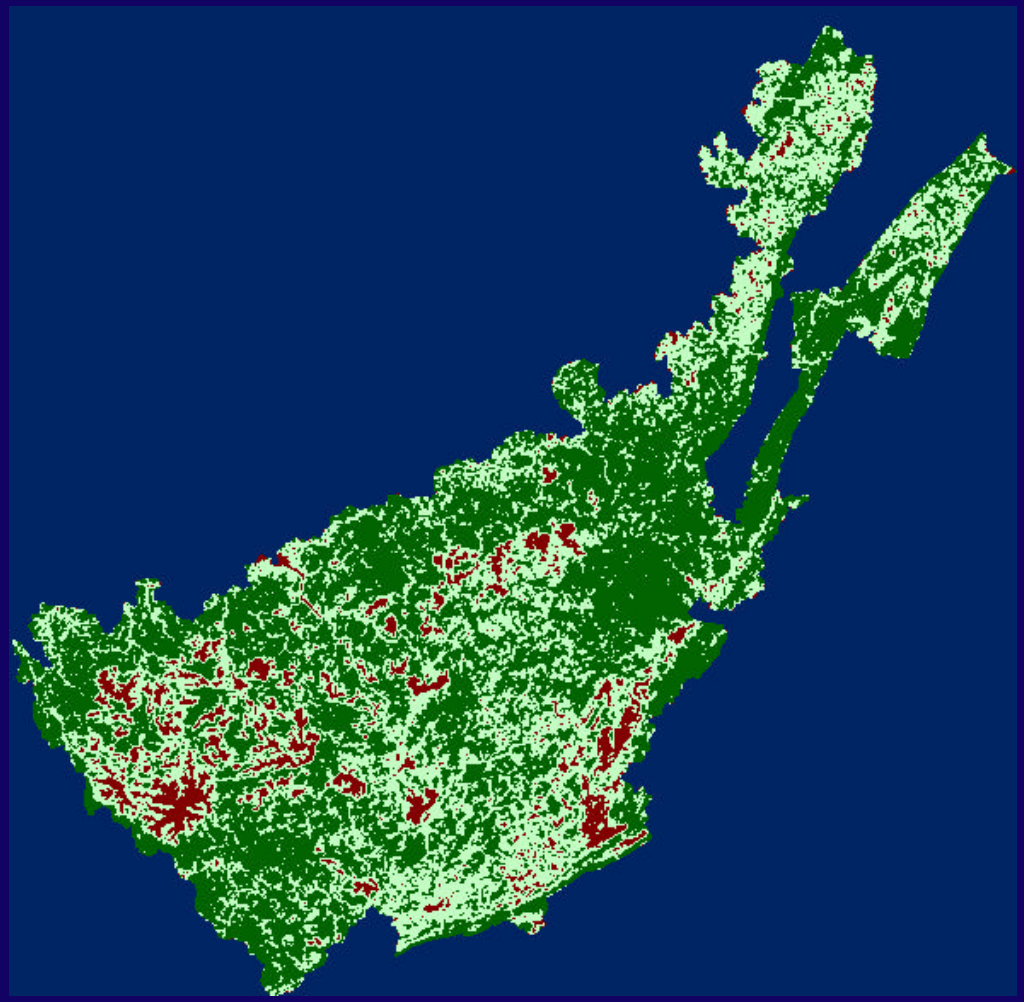
Impact of Mining Activities on National % Forest Ranking

Future Mining Scenario



Percent Forested

- >= 89%
- < 89%



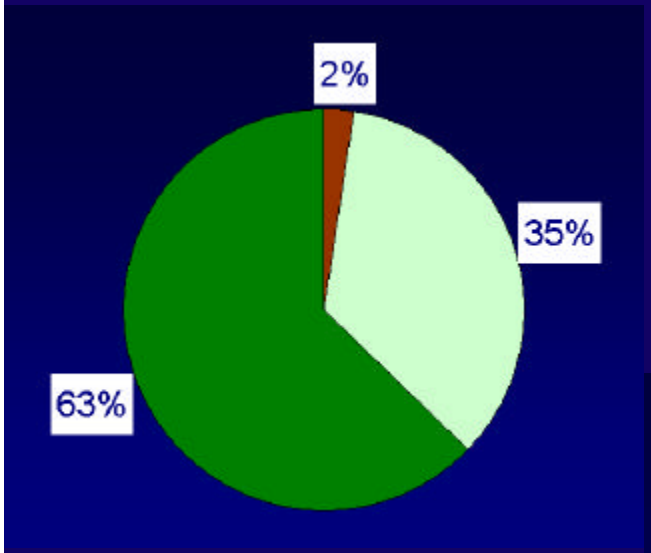
Good/ excellent Average Poor

Bird Community Index in WV Study Area
Land use scenario #3: Future Scenario

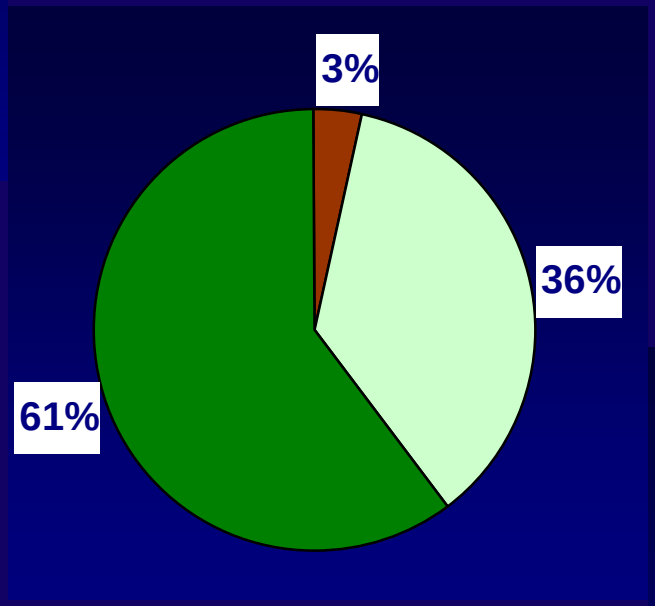
Bird Community Index

Central Appalachian Ecoregion

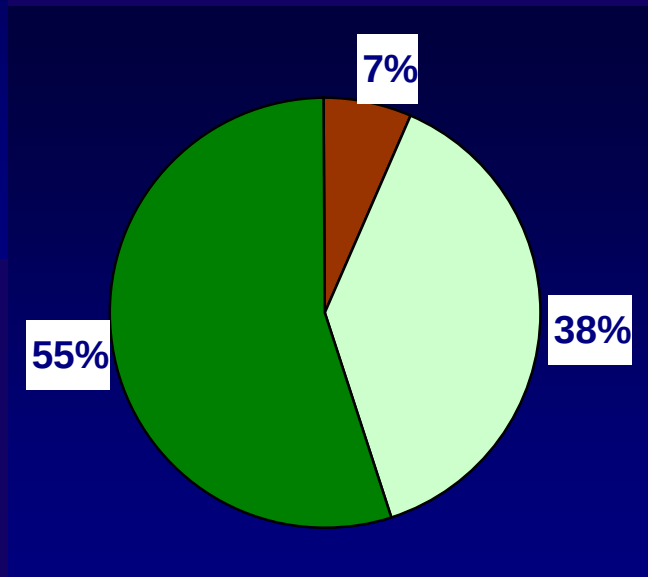
Baseline



Near future



Future Mining



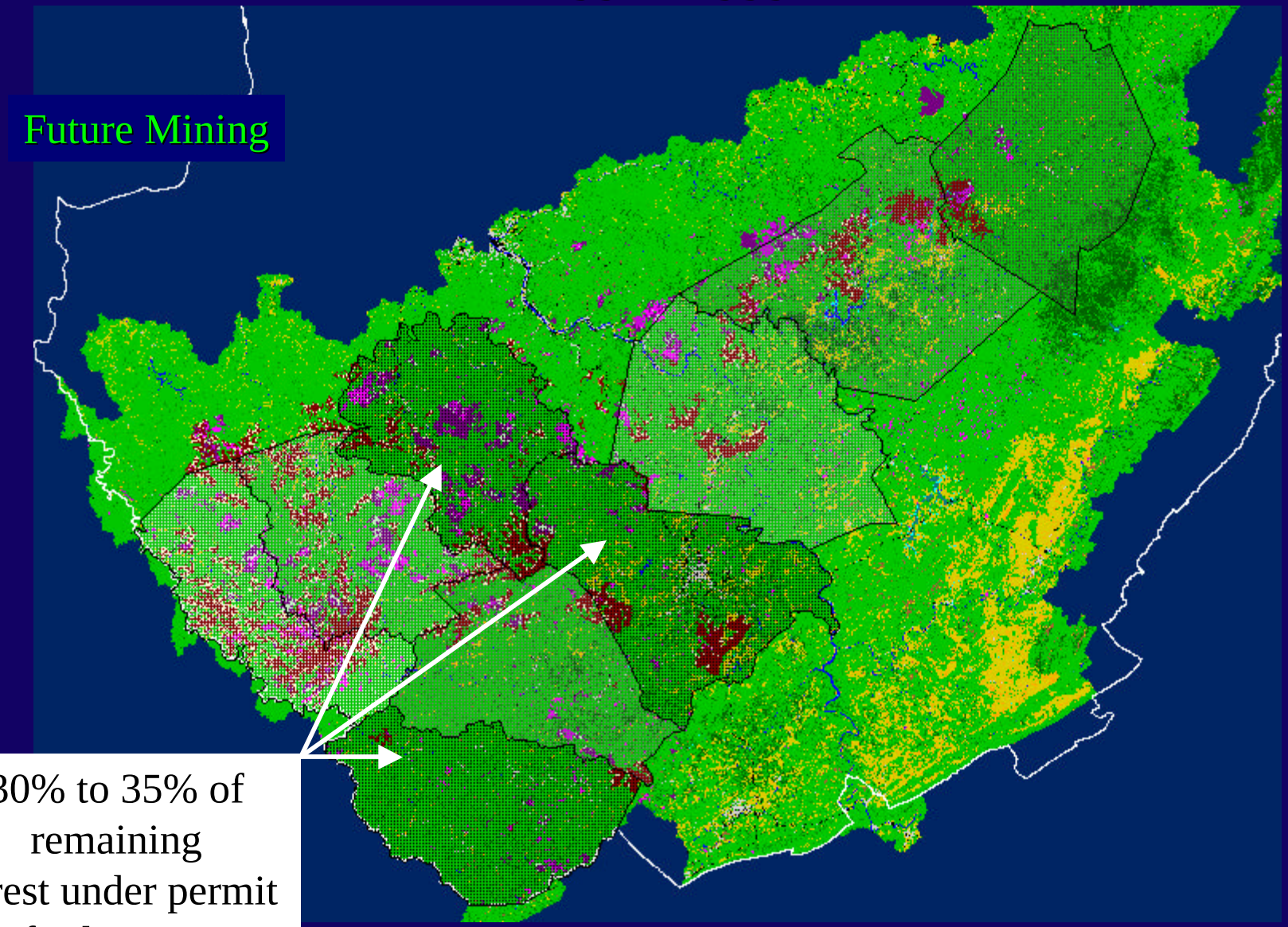
Good/ excellent

Average

Poor

Total Area:
7,427,855 acres

Percent of remaining forest with timber permits
1992 - 1999

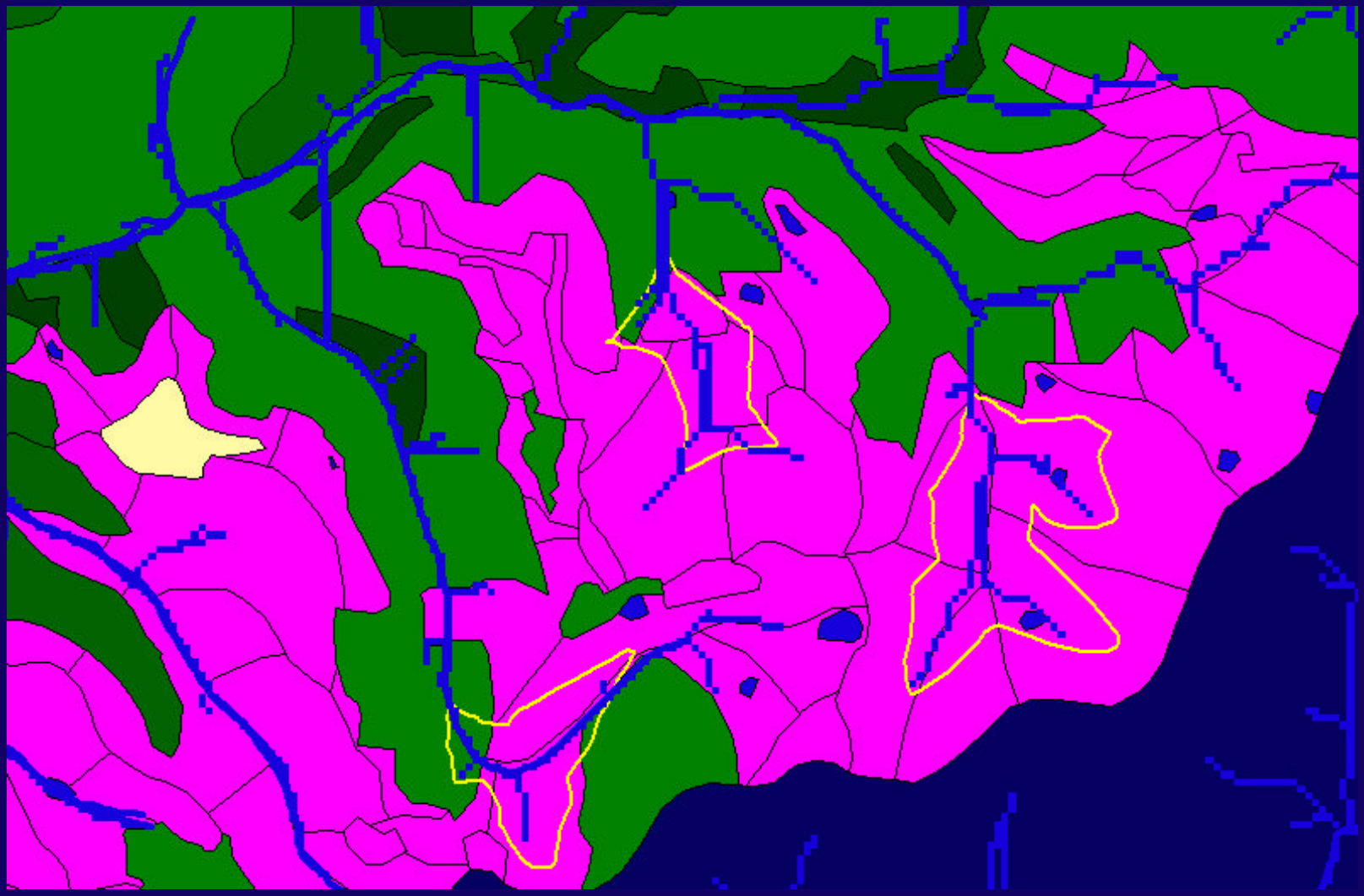


30% to 35% of remaining forest under permit for logging

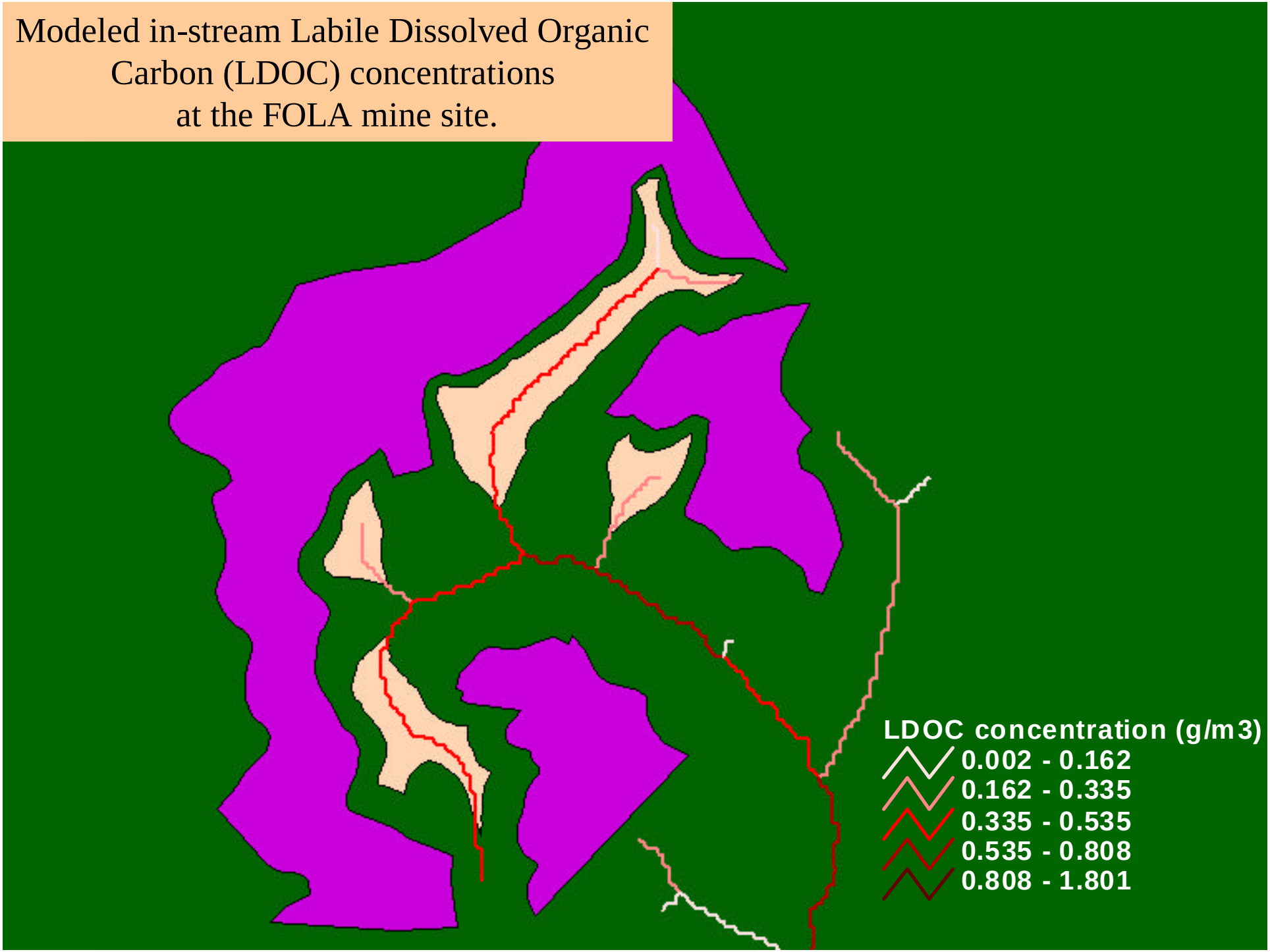
Data courtesy of WV Division of Forestry

Data Accuracy cont.

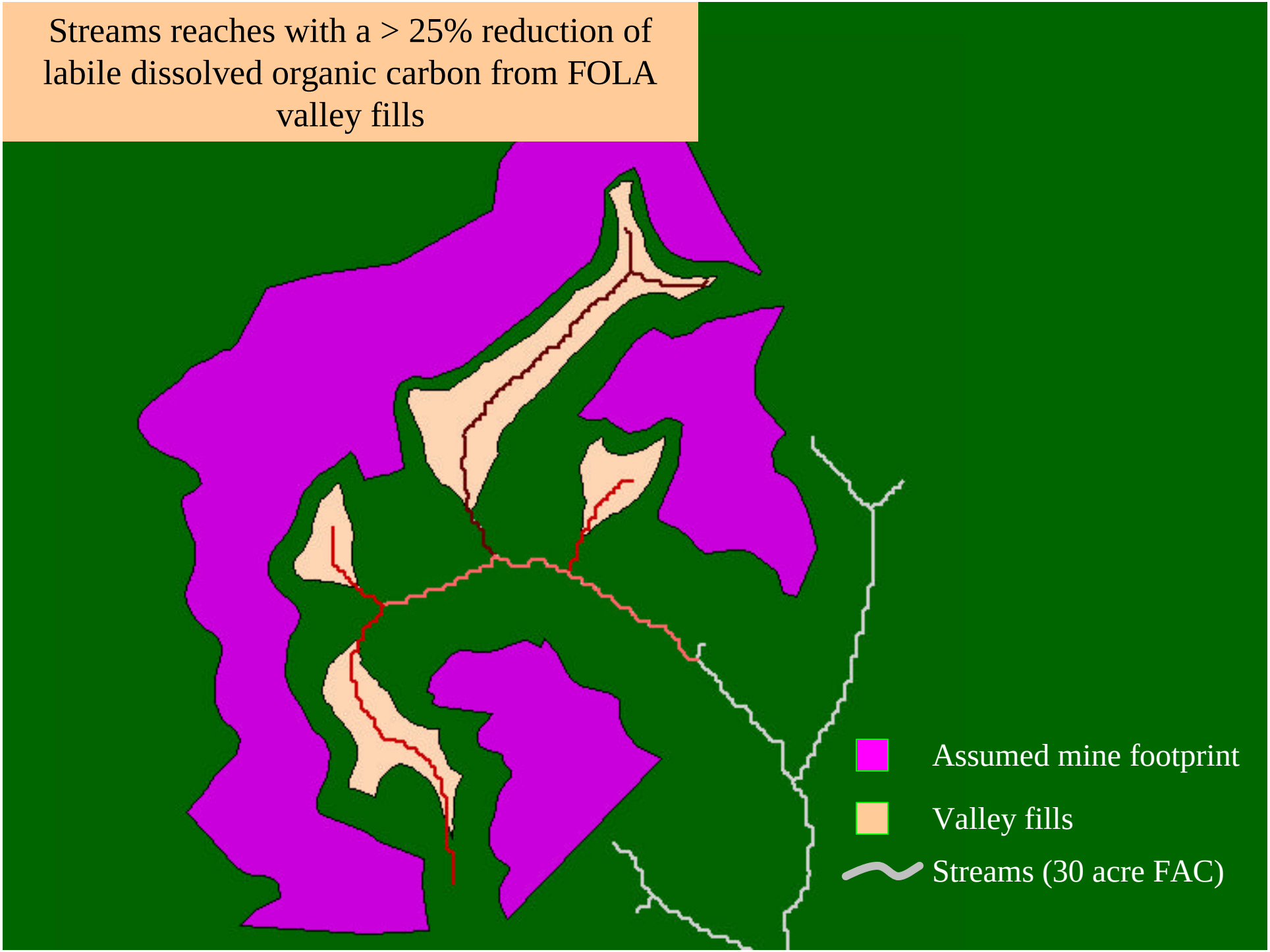
(river reaches)



Modeled in-stream Labile Dissolved Organic Carbon (LDOC) concentrations at the FOLA mine site.

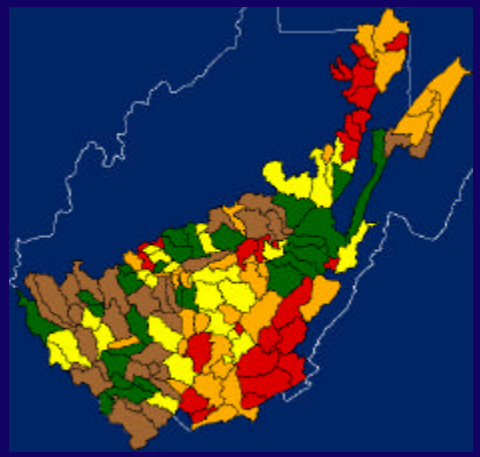


Streams reaches with a > 25% reduction of labile dissolved organic carbon from FOLA valley fills



Changes to Ecological Endpoints

Current Rank
(% forest cover)



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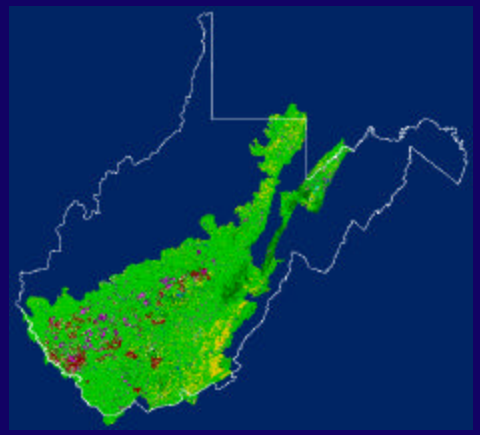
Proposed mines



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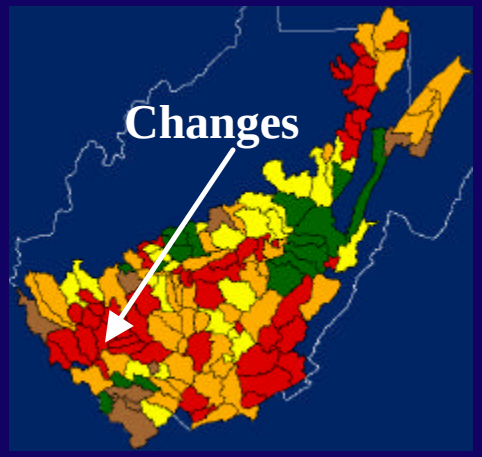
Future Rank
(% forest cover)



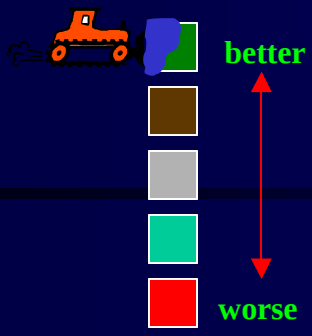
→ Reduction in habitat area for interior species

&

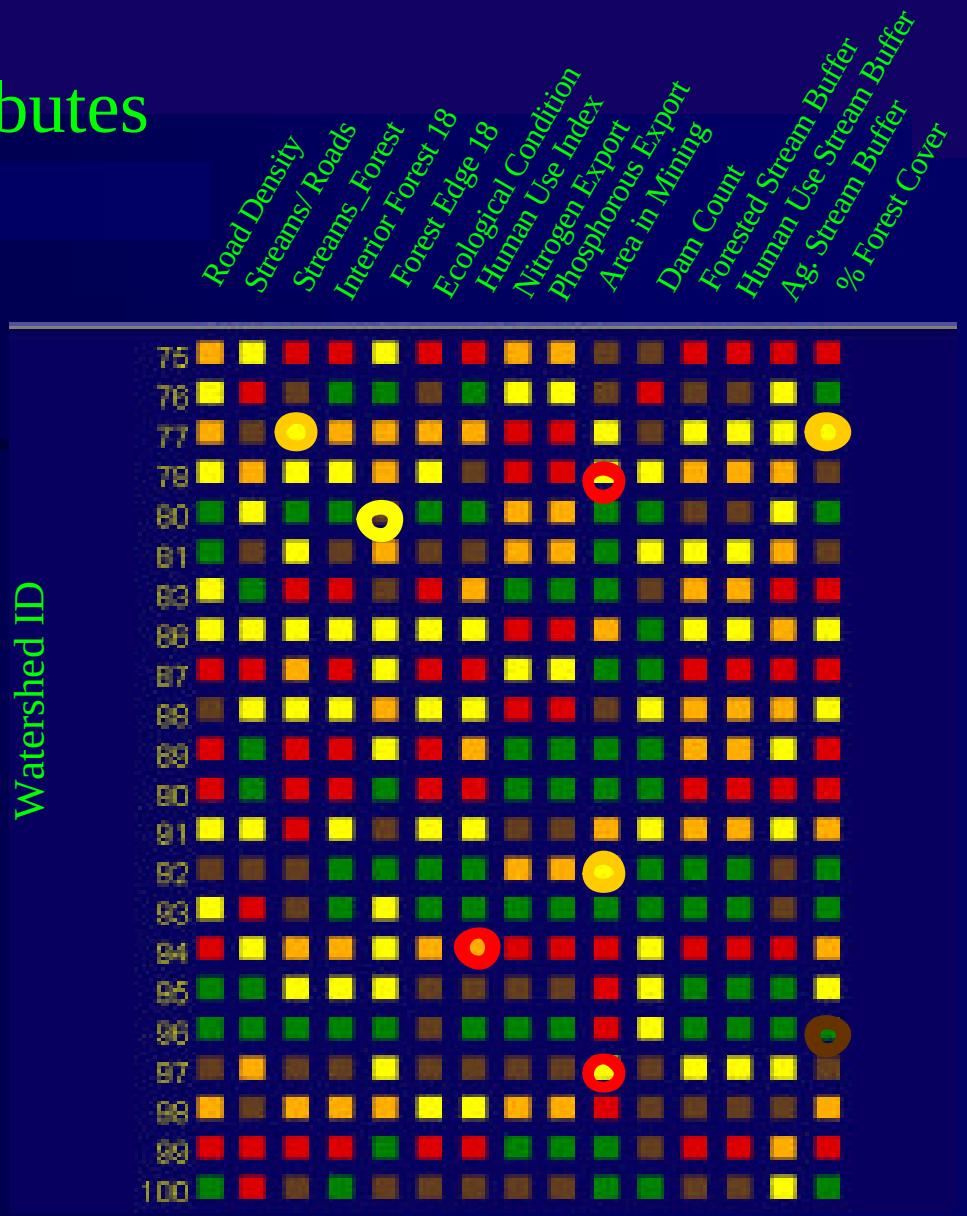
Increase in habitat area for generalist species

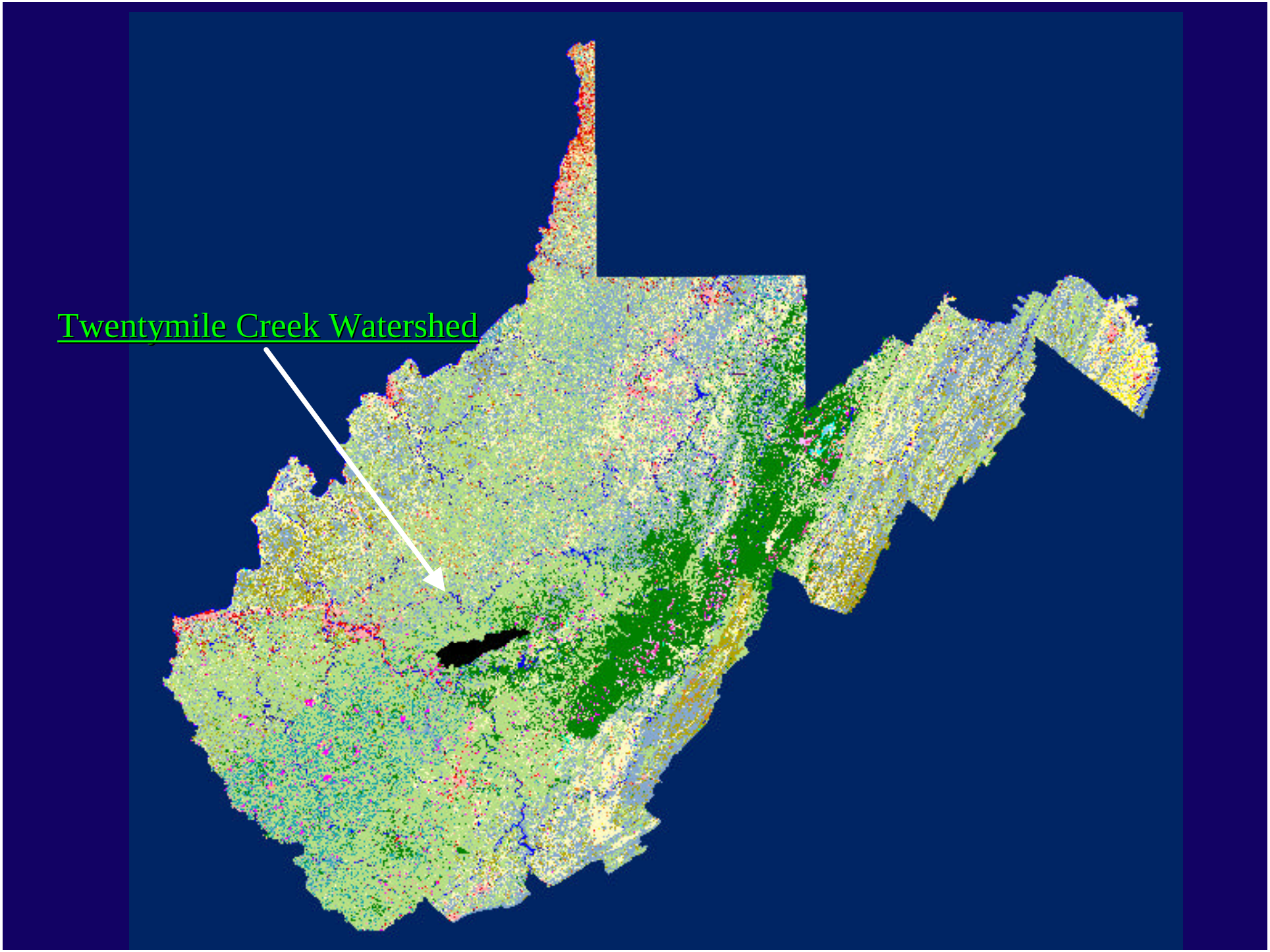
Or?

Changes in watershed attributes



12,800 acres of forest altered




Twentymile Creek Watershed

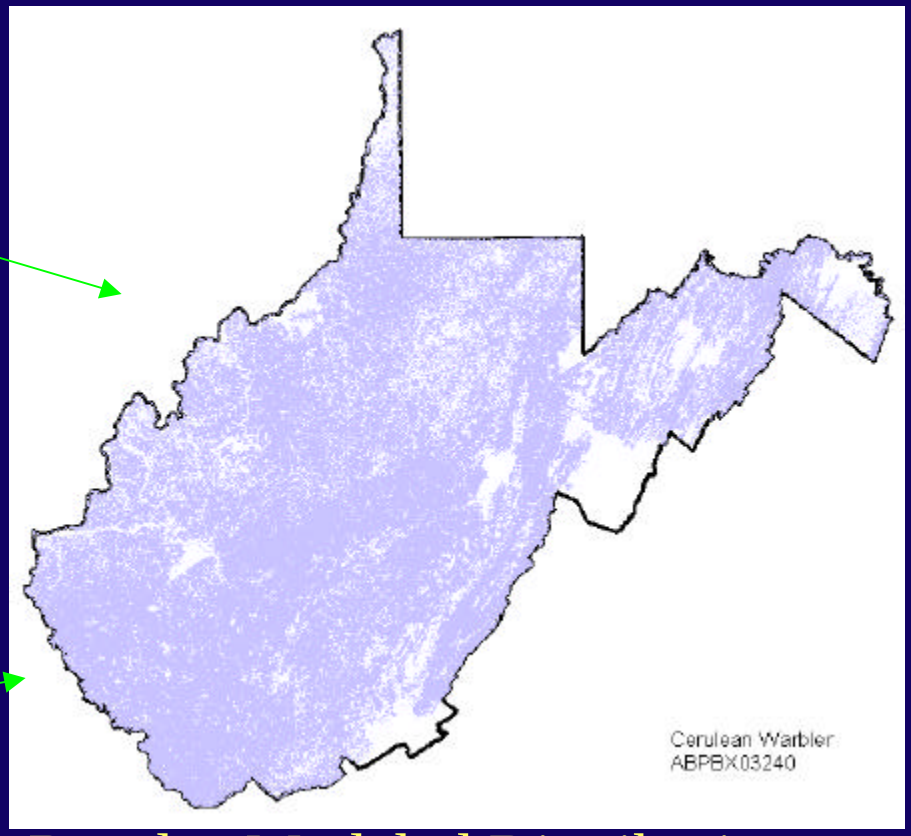
Cerulean Warbler – WV-GAP Distribution Mapping

Example

Input – Range Map

Habitat Types Associated with Species:
Surface water
Floodplain forest
Cove hardwood forest
Diverse/mesophytic hardwood forest
Hardwood/conifer forest
Oak dominant forest
Mountain hardwood forest

Input – Habitat Associations



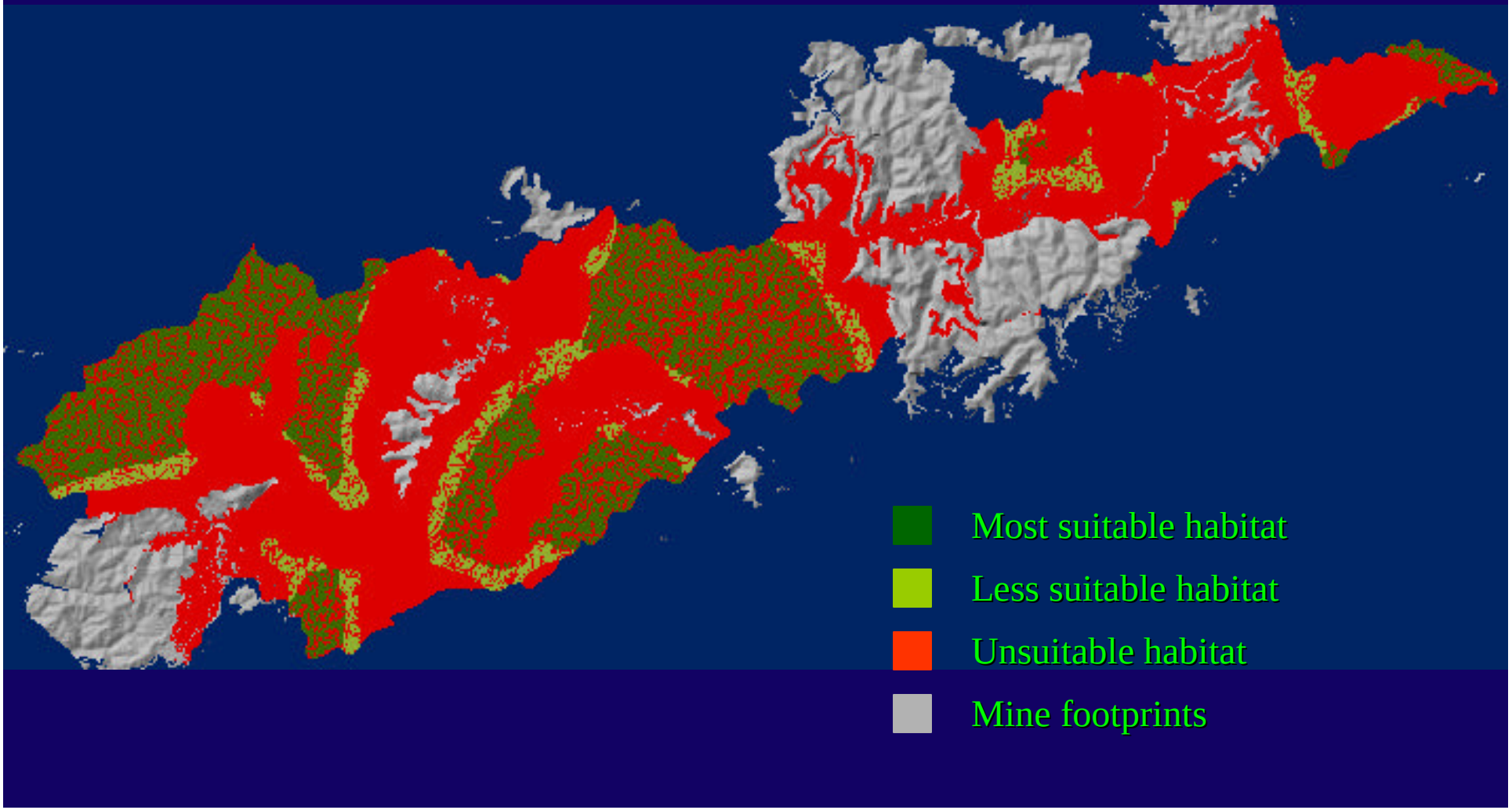
Result - Modeled Distribution

Slide courtesy of Jackie Strager, WV GAP Coordinator

Cerulean Warbler Habitat Model

GIS datasets	Derived data layers	Model criteria
DEM →	Slope……	<= 61% and >= 35%
	Moisture index……	< 27 or < 52
	Surface curvature…….	Convex
	Drainage area……....	>= 9 and <= 45
Multi-spectral satellite imagery →	Forest cover……	Deciduous or mixed forest

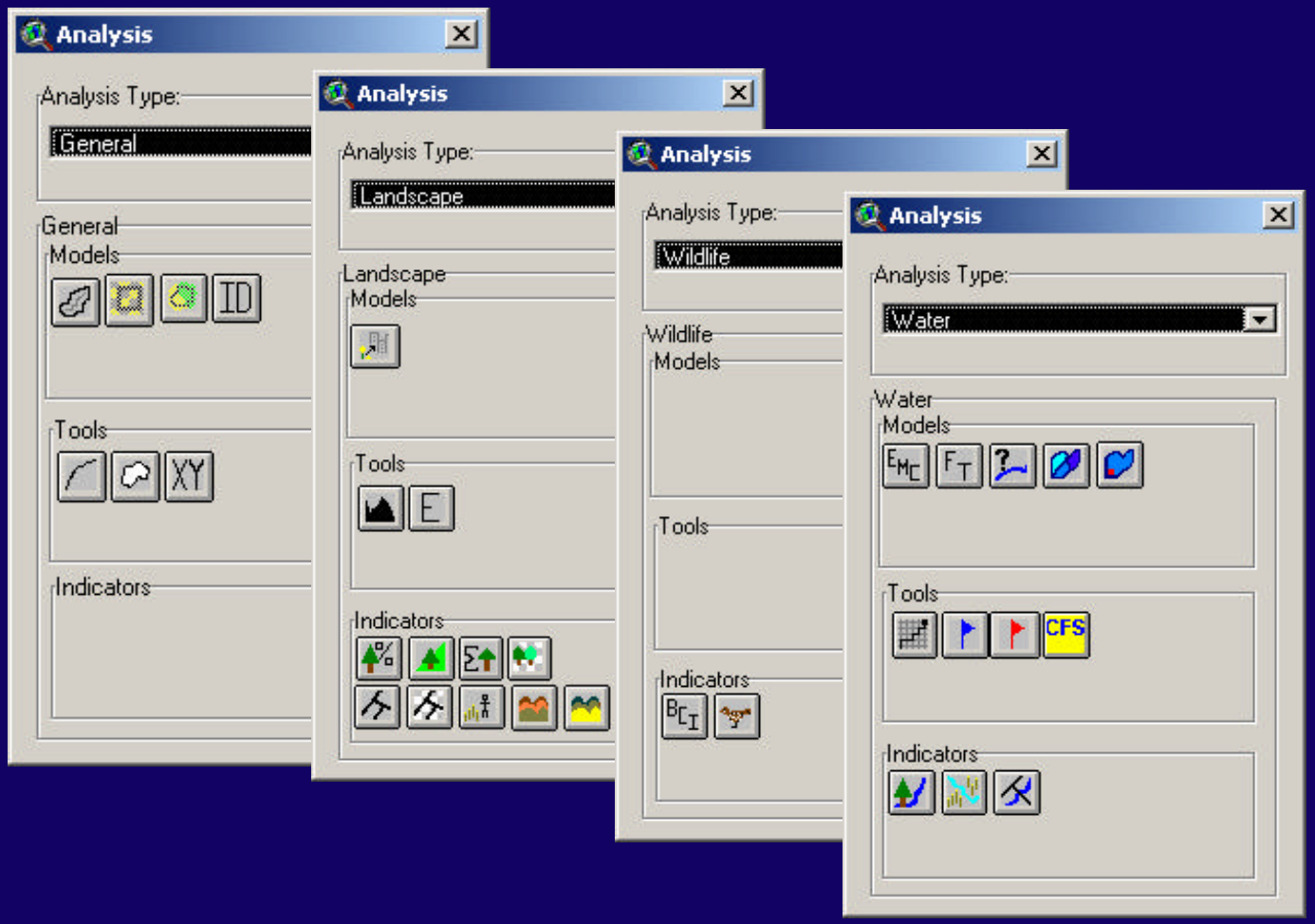
Cerulean Warbler Suitable Habitat
1999 Land cover + Future mine permits



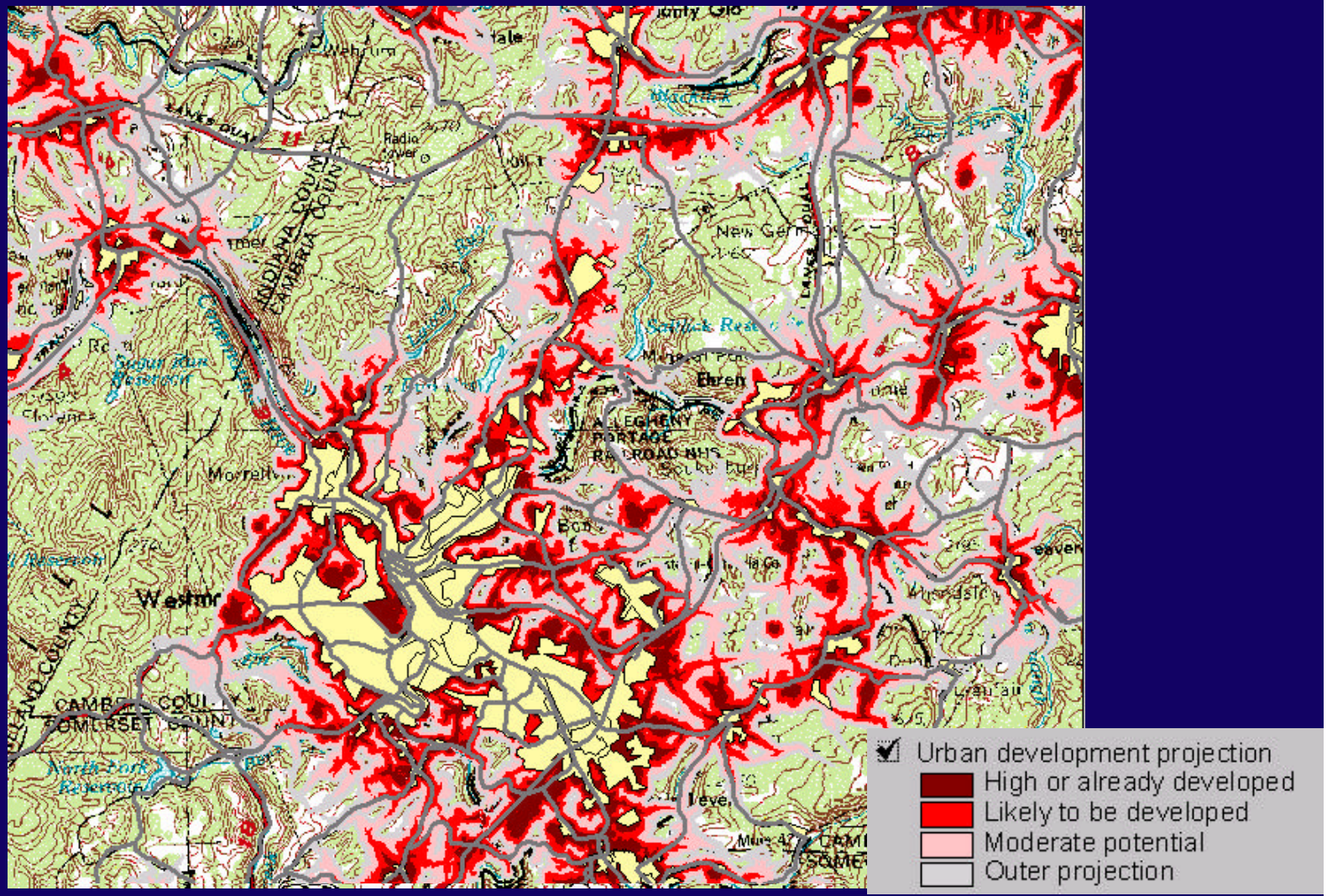
Case Example 2: Sprawl

- Predicting sprawl- based on factors of impedance and growth
- Managing sprawl: regional, local, site-specific

Landscape Analyst Models,Tools, Indicators



Potential Growth- High Density Areas



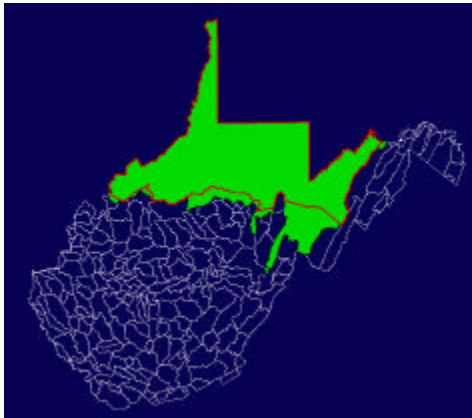
Regional Strategic Application

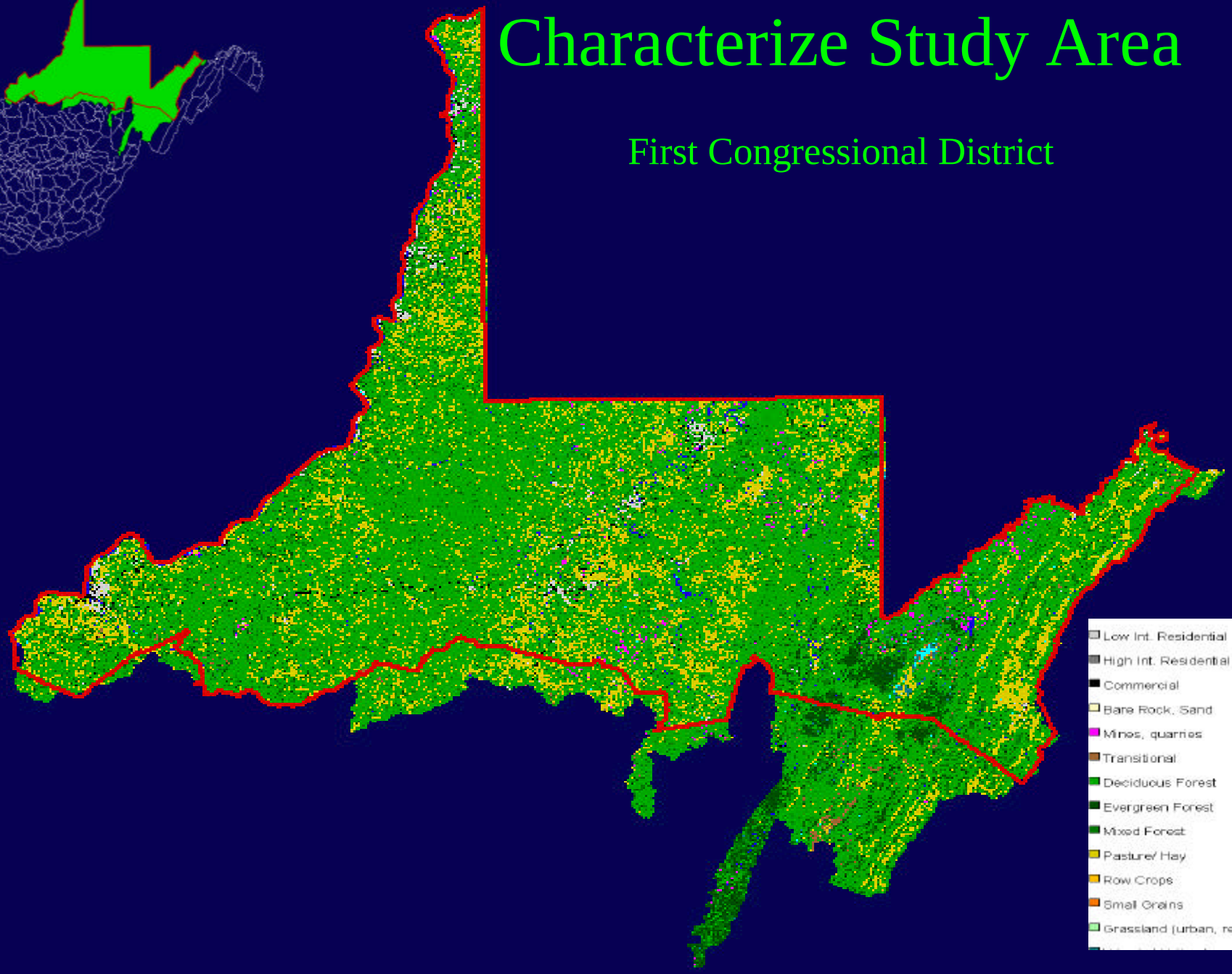
Hypothetical Goals:

- Characterize and understand the region
- Develop sustainable growth corridors
- Preserve or improve regional ecological condition
- Focus regulatory and non-regulatory resources on most pressing environmental conditions
- Measure success
- Involvement of local stakeholders

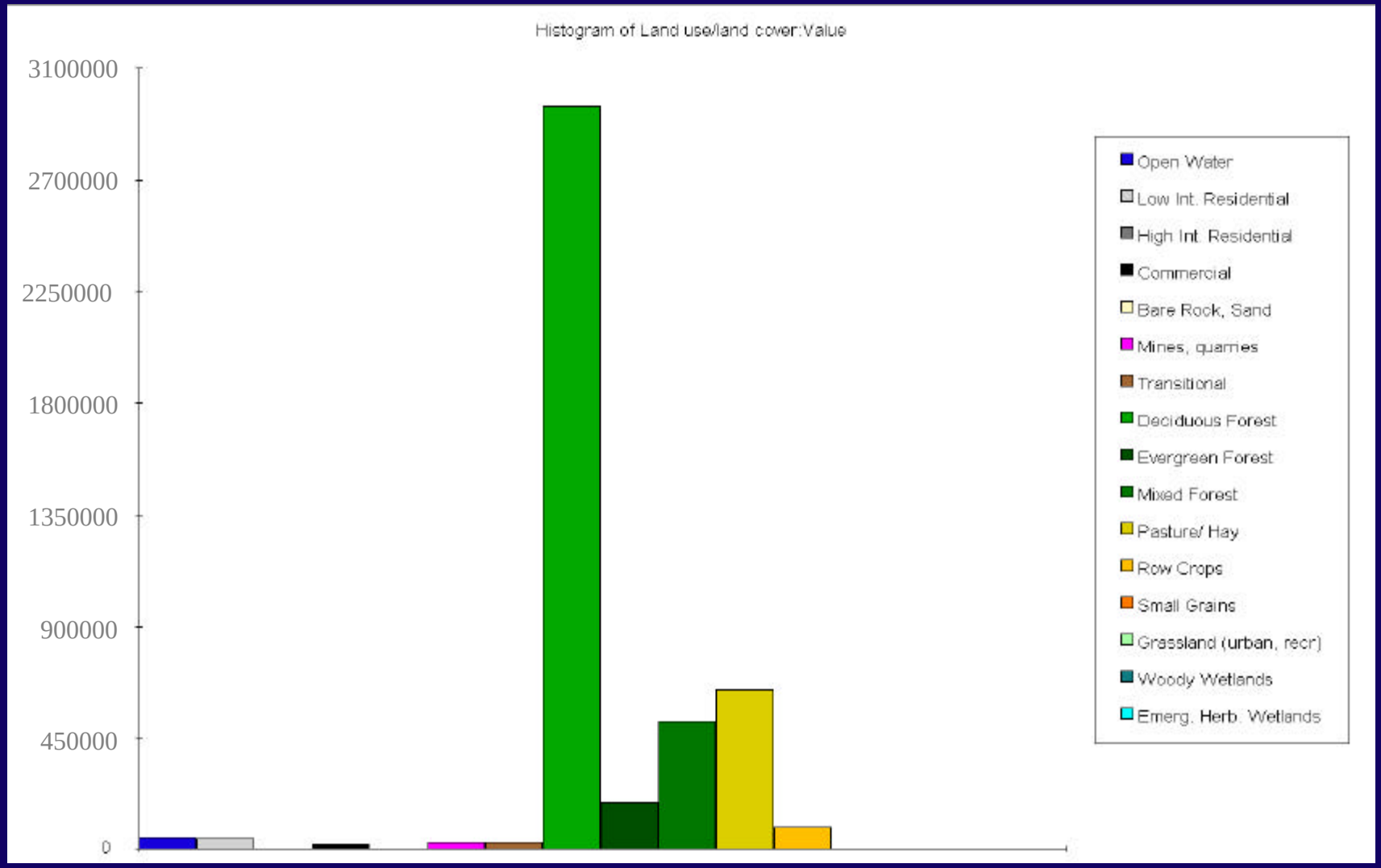
Characterize Study Area

First Congressional District



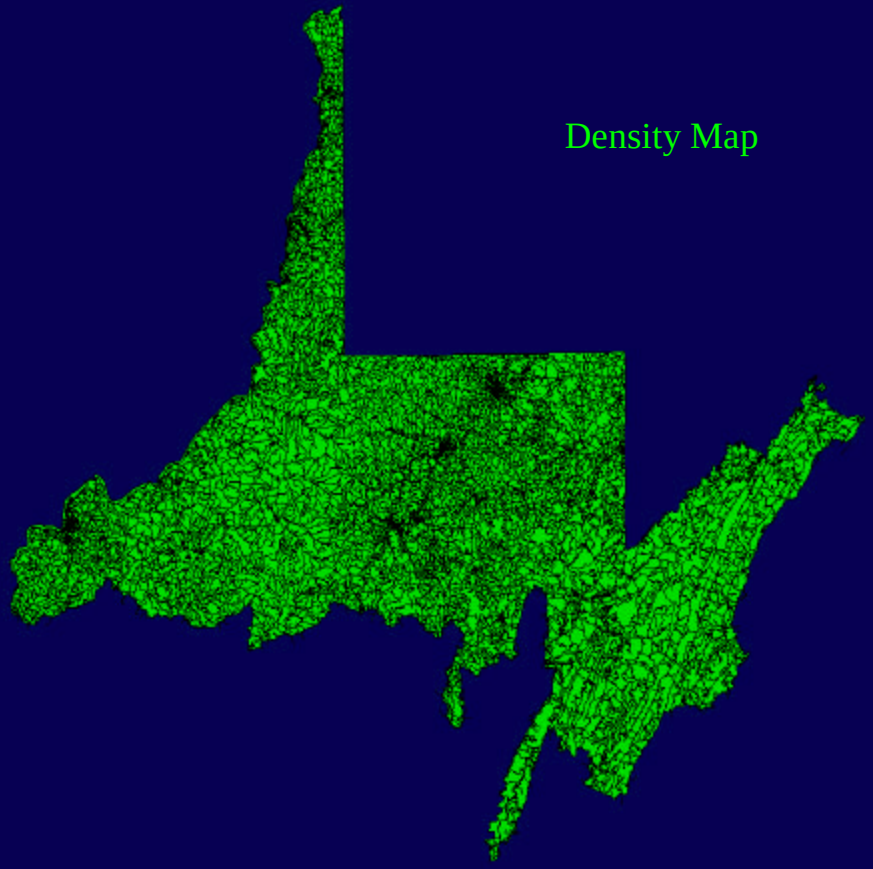


Land use/land cover of First Congressional District

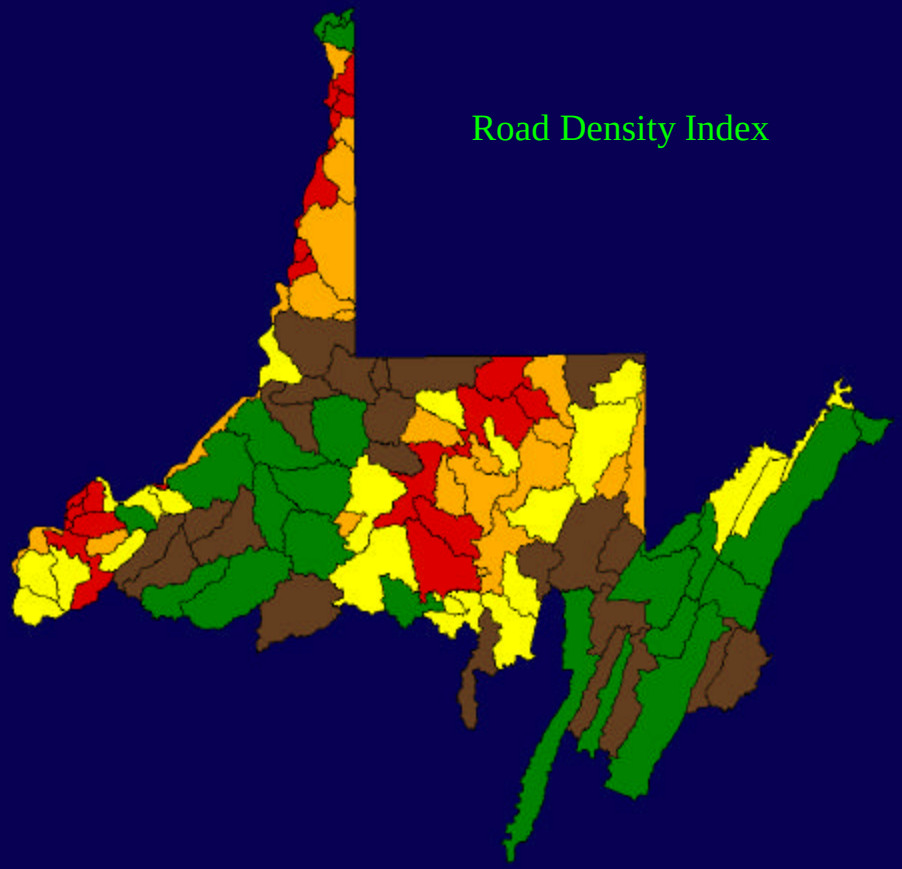


Road Density

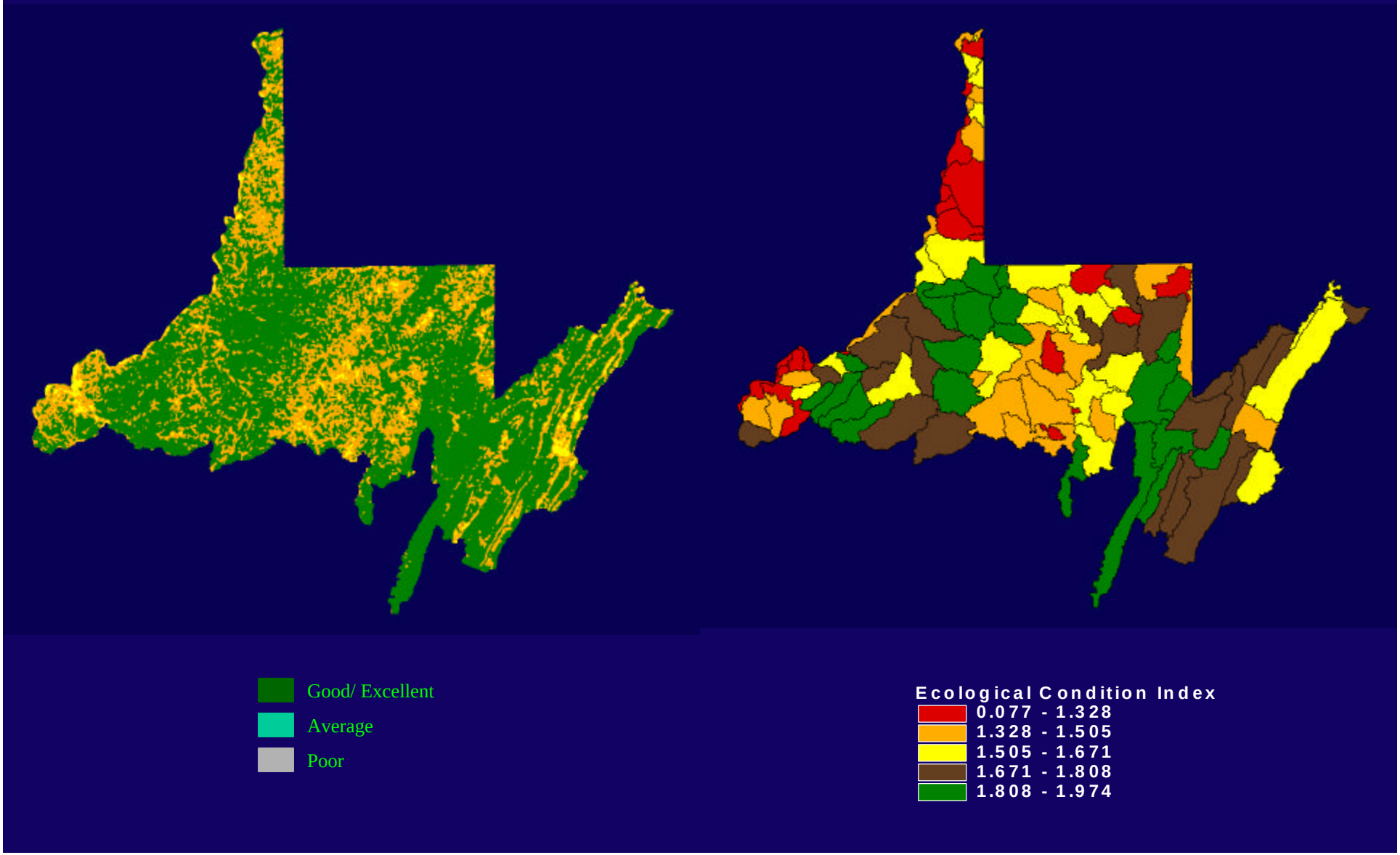
Density Map



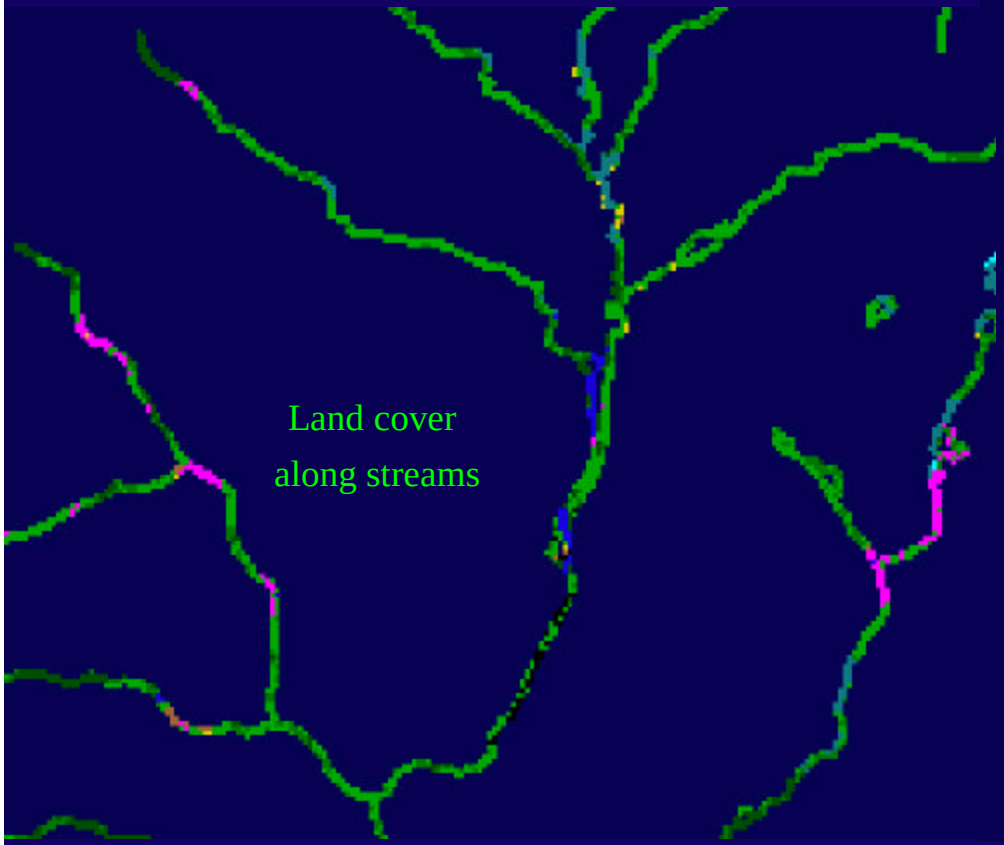
Road Density Index

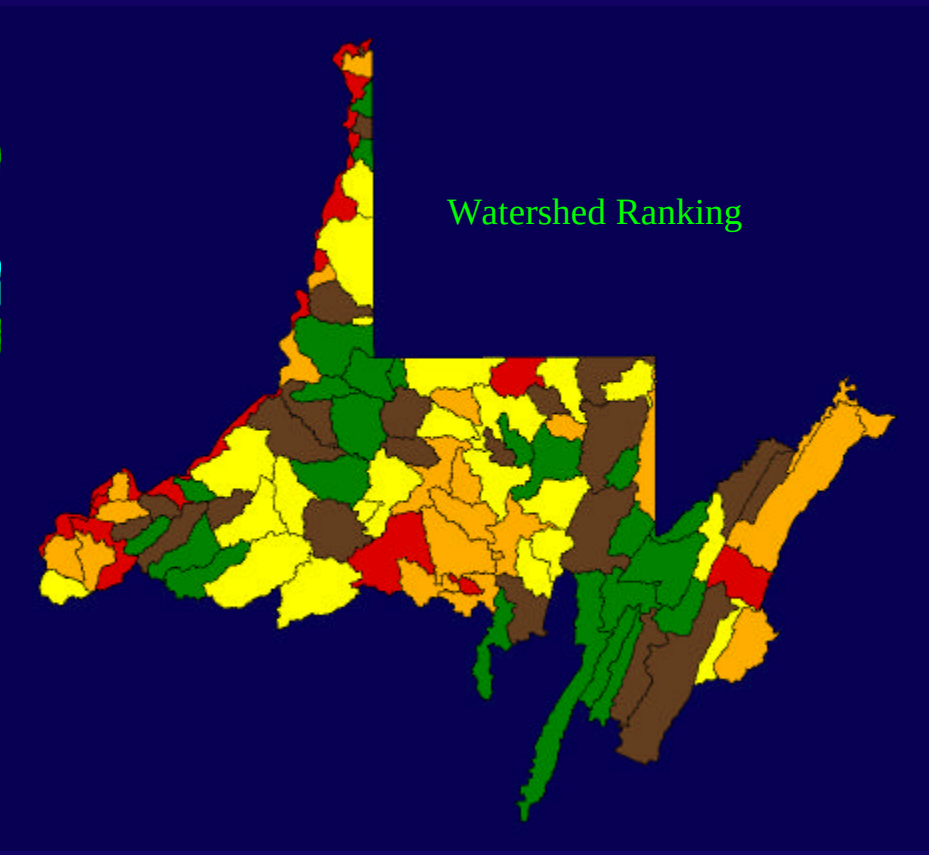


Ecological Condition



Stream Length Through Human-Influenced Land Uses



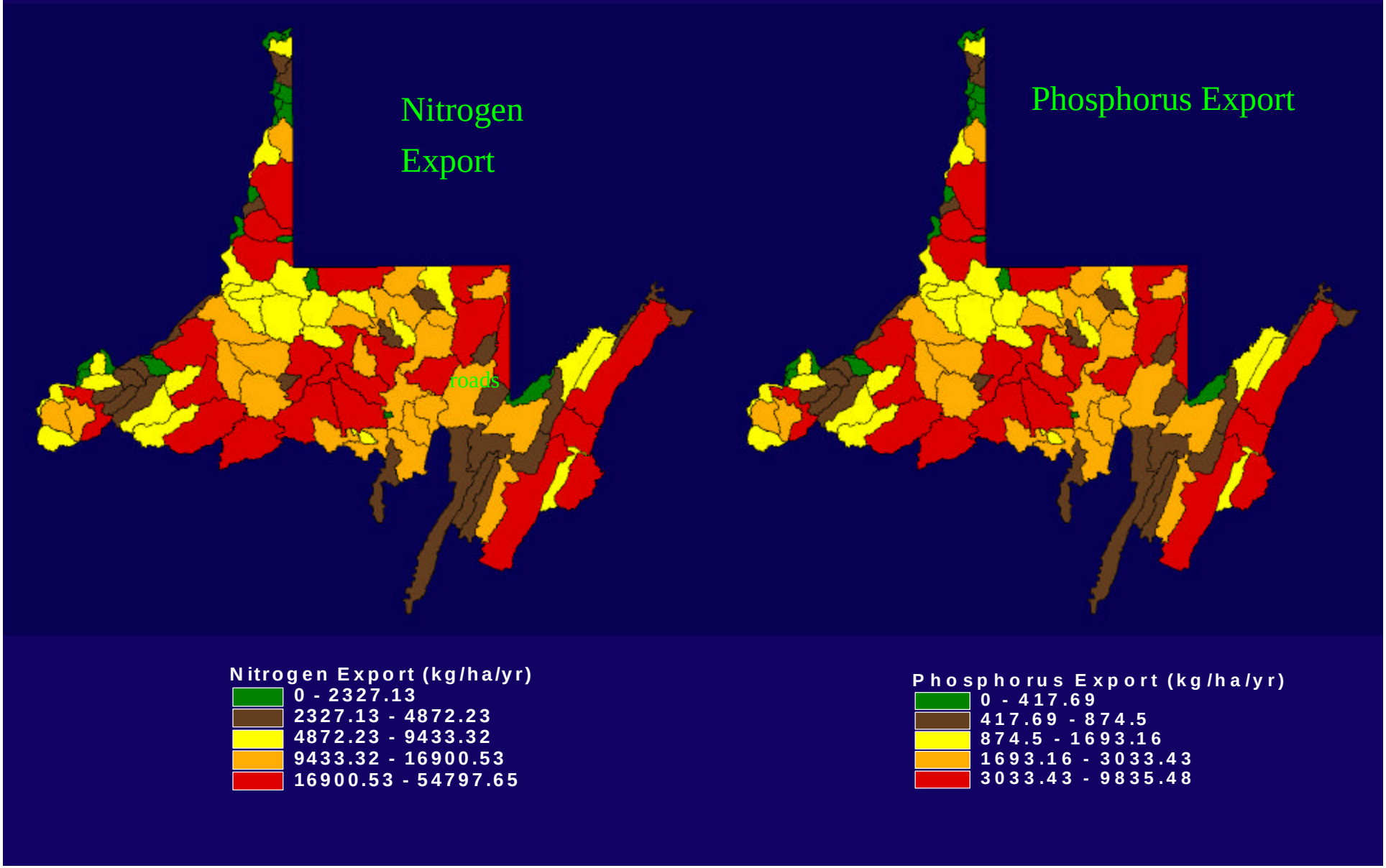


Deciduous Forest
Evergreen Forest
Agricultural
Mining
Palustrine Wetland
Open Water
Commercial

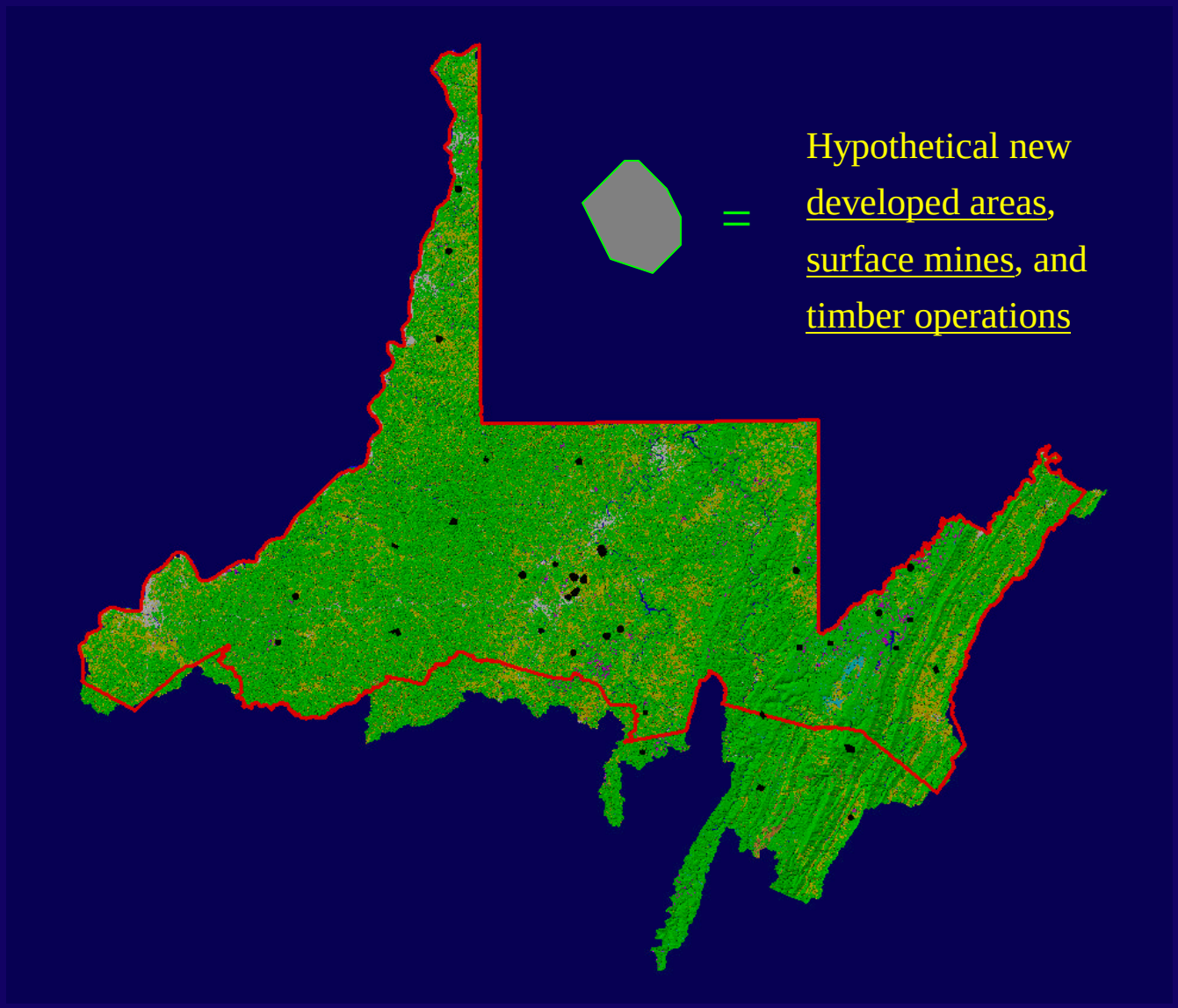
Percent Stream Length

0.035 - 0.125
0.125 - 0.167
0.167 - 0.239
0.239 - 0.348
0.348 - 0.894

Landscape Modeled Water Quality

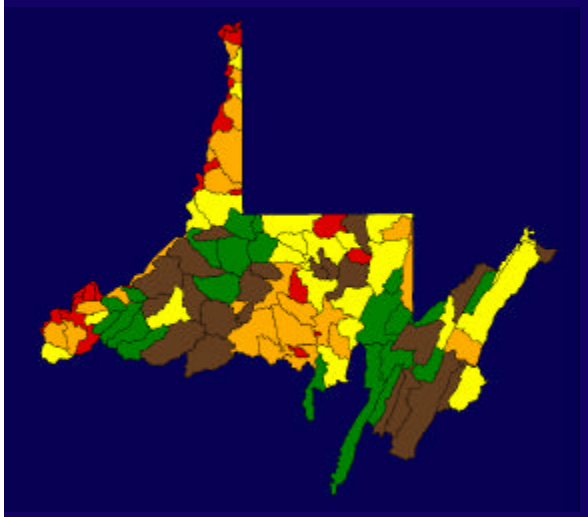


Model landscape changes

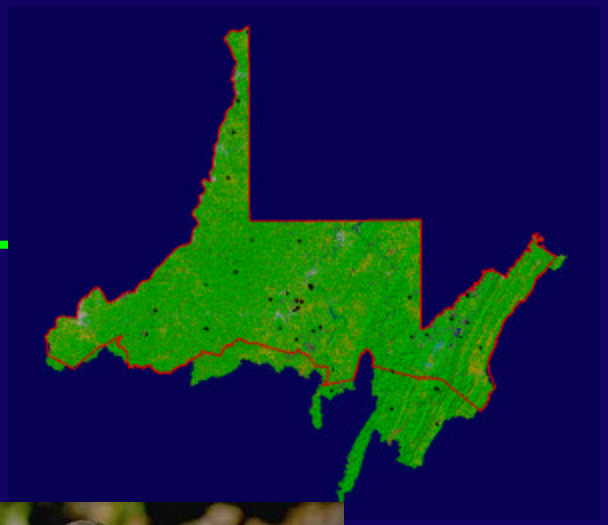


Changes to Ecological Endpoints

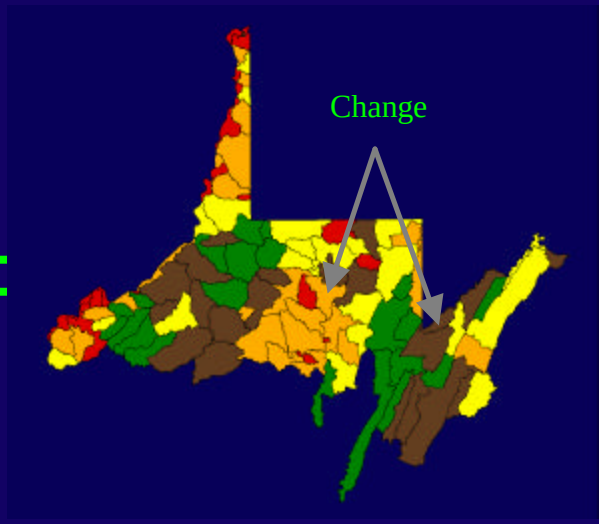
Current Rank
(% forest cover)



New developments, mines, etc.



Future Rank
(% forest cover)



Reduction in habitat area for interior species

&

Increase in habitat area for generalist species

Local and Site Specific Application

Develop & select alternative solutions

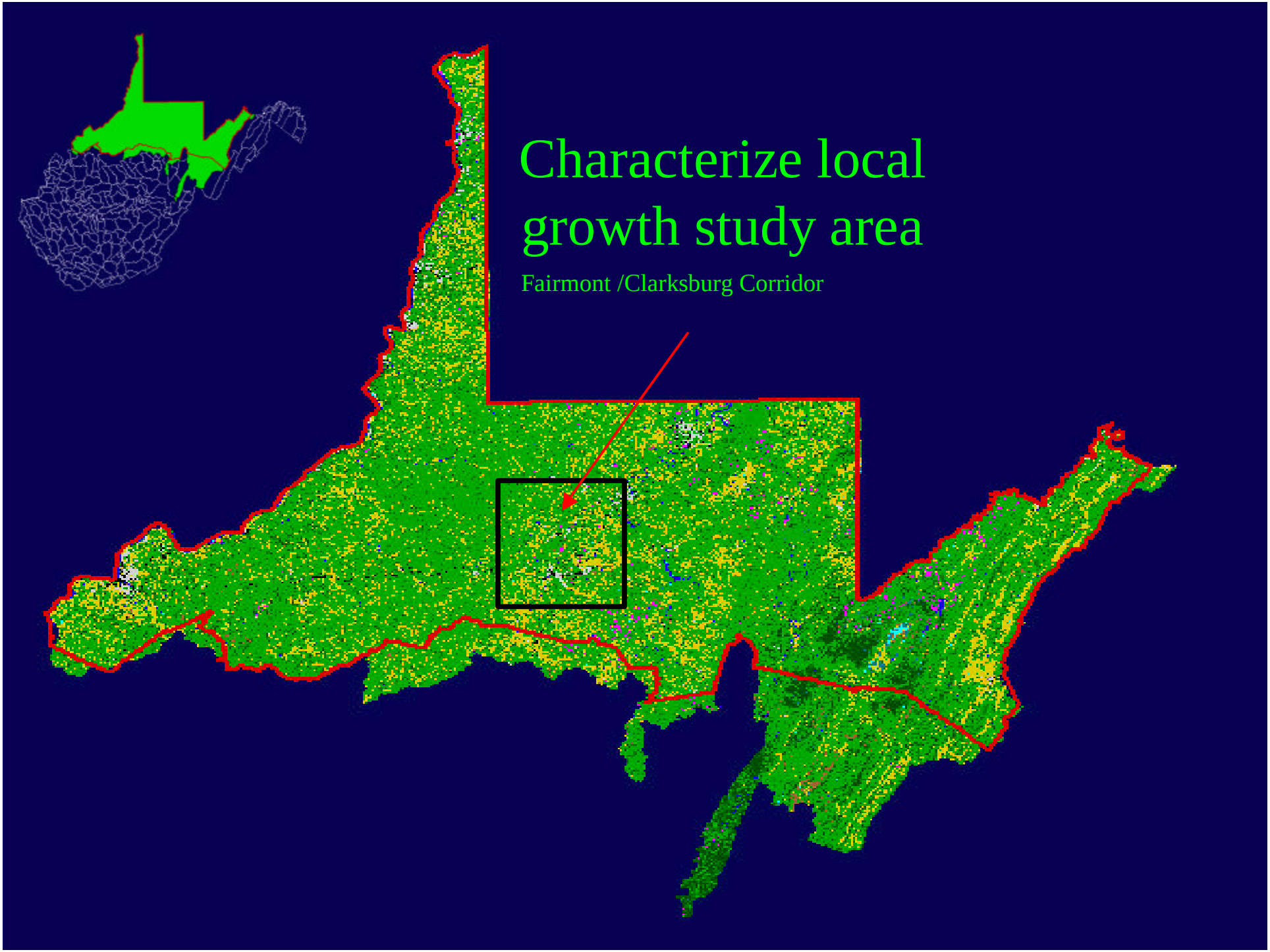
Implement & evaluate selected solutions

Hypothetical Goals:

- Develop Industrial parks, shopping malls, and airport at selected sites
- Preserve or improve ecological condition

Objectives:

- Identify site building constraints
- Identify site specific ecologically significant areas
- Apply appropriate buffers
- Identify and institute mitigation restoration

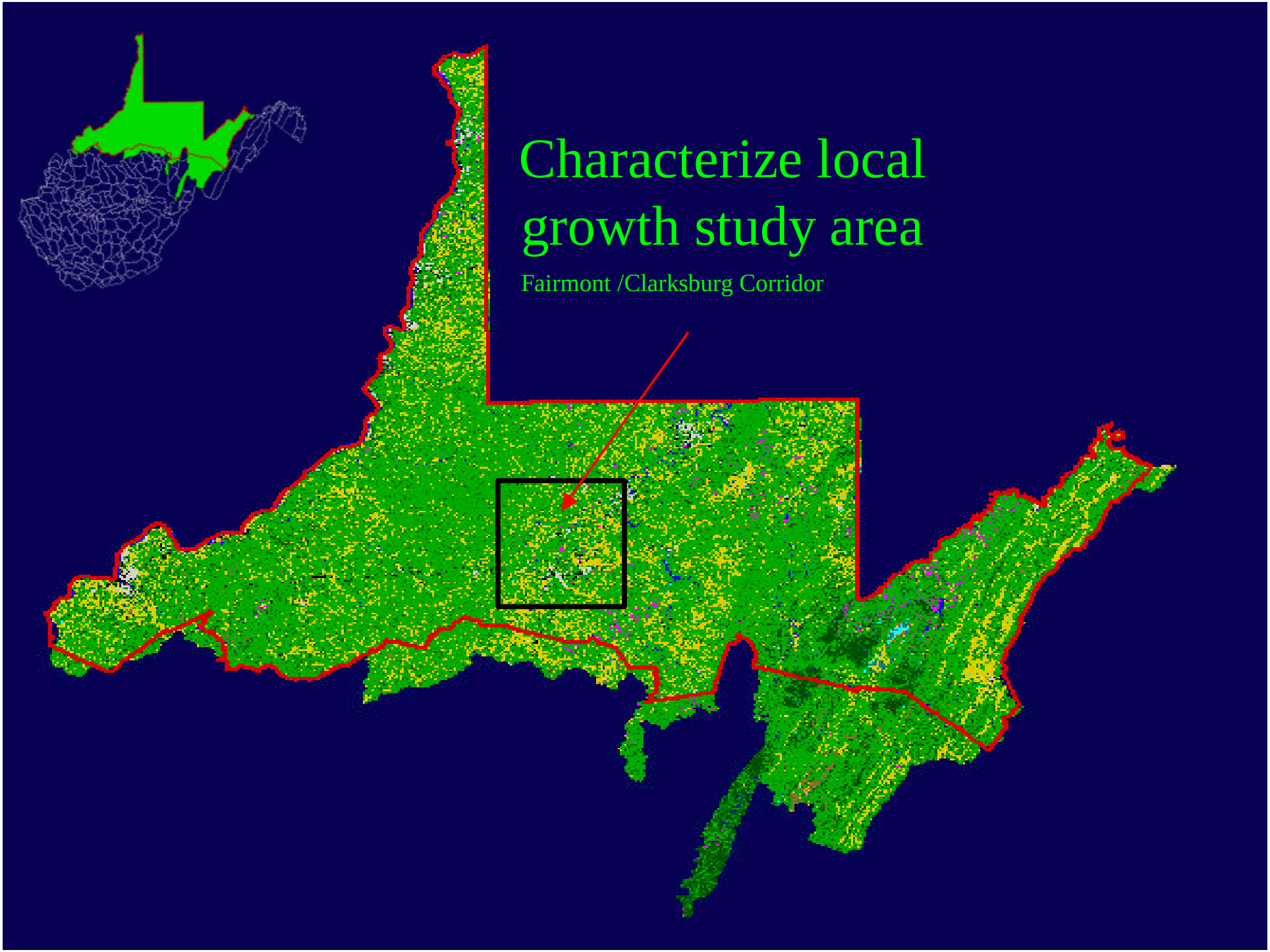

Characterize local growth study area
Fairmont /Clarksburg Corridor

Physical and Economic Development Constraints

- Steep slopes (>25%)
- Previously developed land (e.g., residential, commercial, mined lands)
- Limited access (few roads)

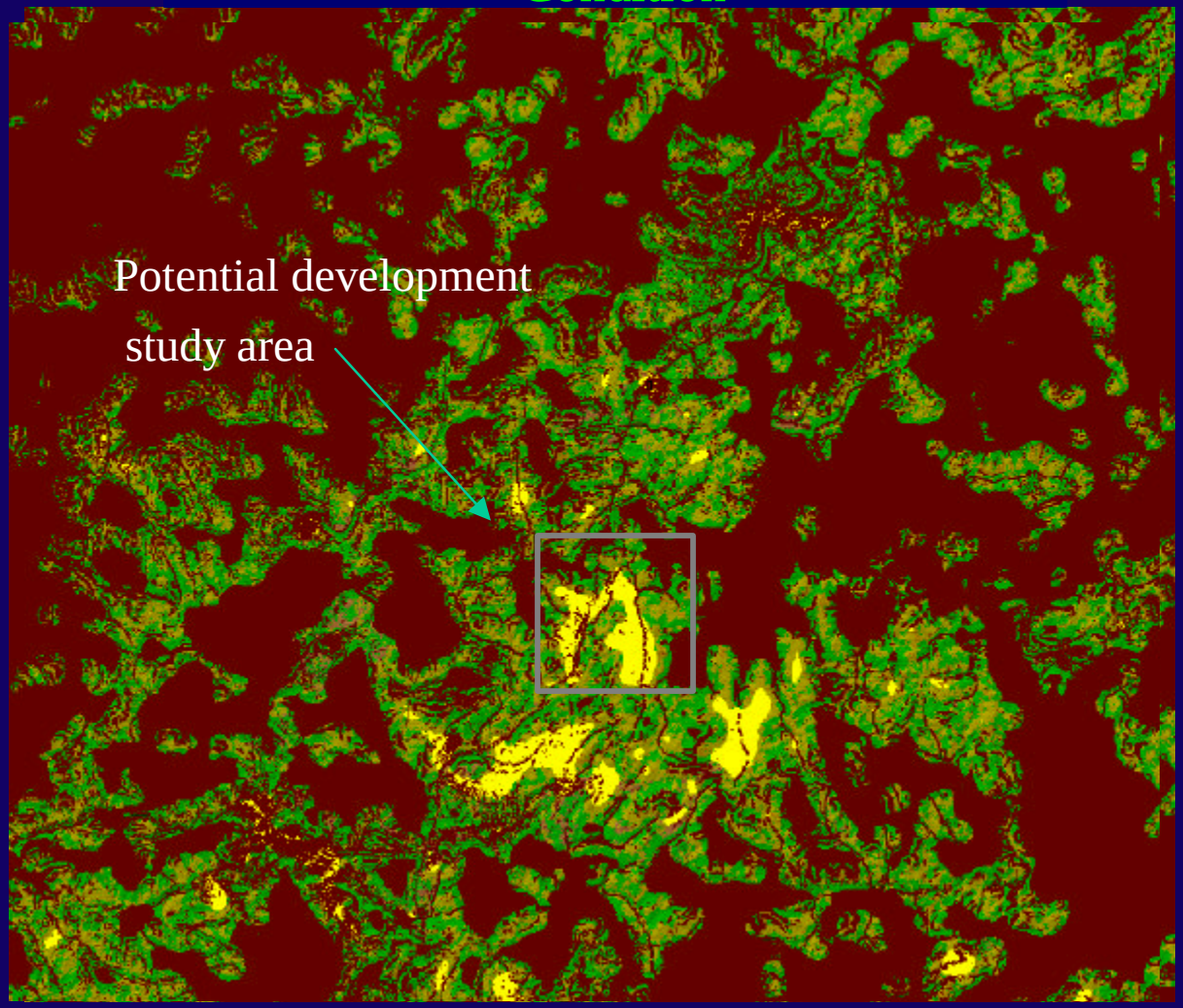
Environmental Development Constraints

- Riparian buffer zones (30m - 60m)
- Regulated land uses (e.g., wetlands)
- Ecologically valuable forests


Characterize local growth study area
Fairmont /Clarksburg Corridor

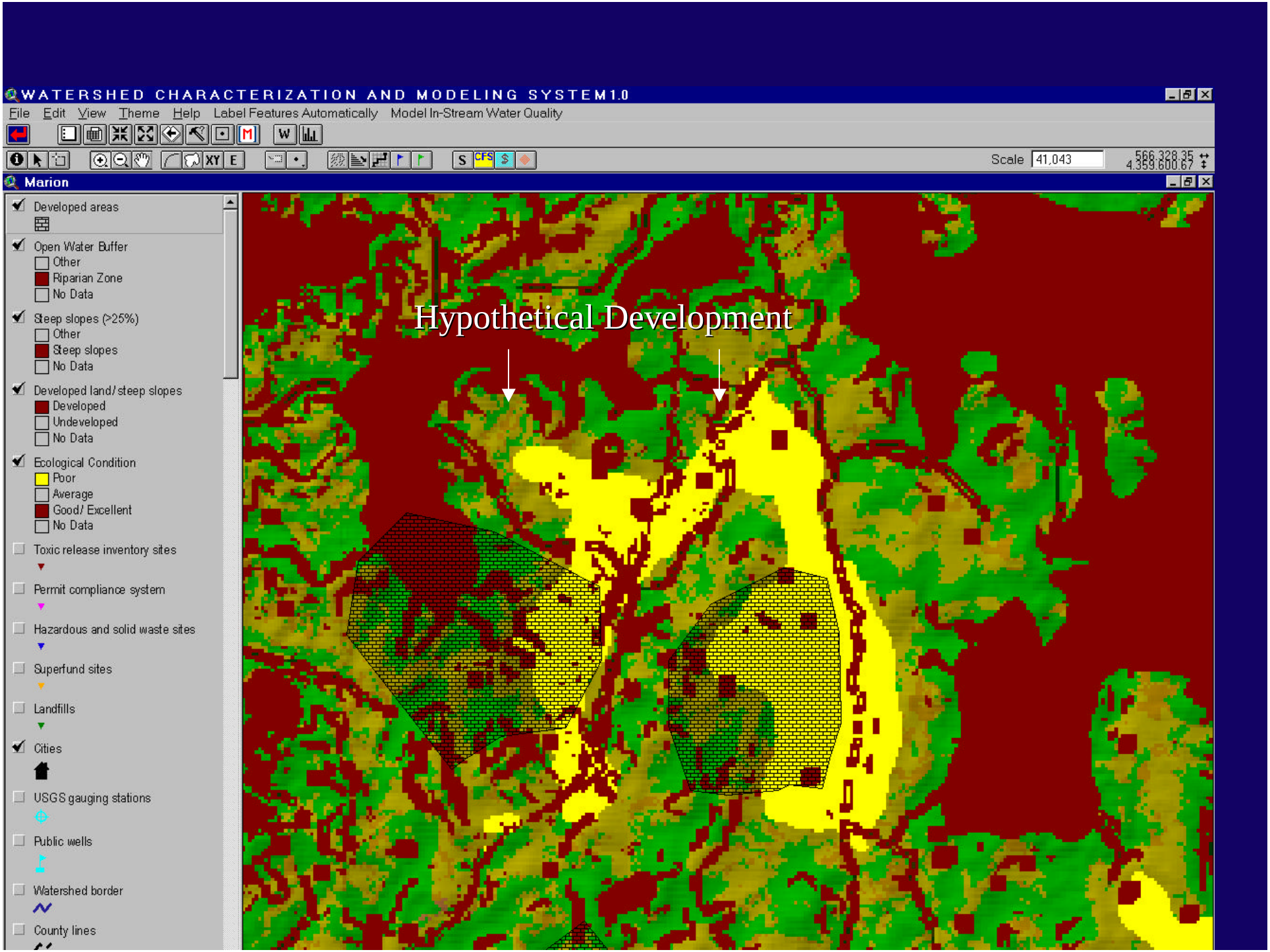
Fairmont / Clarksburg

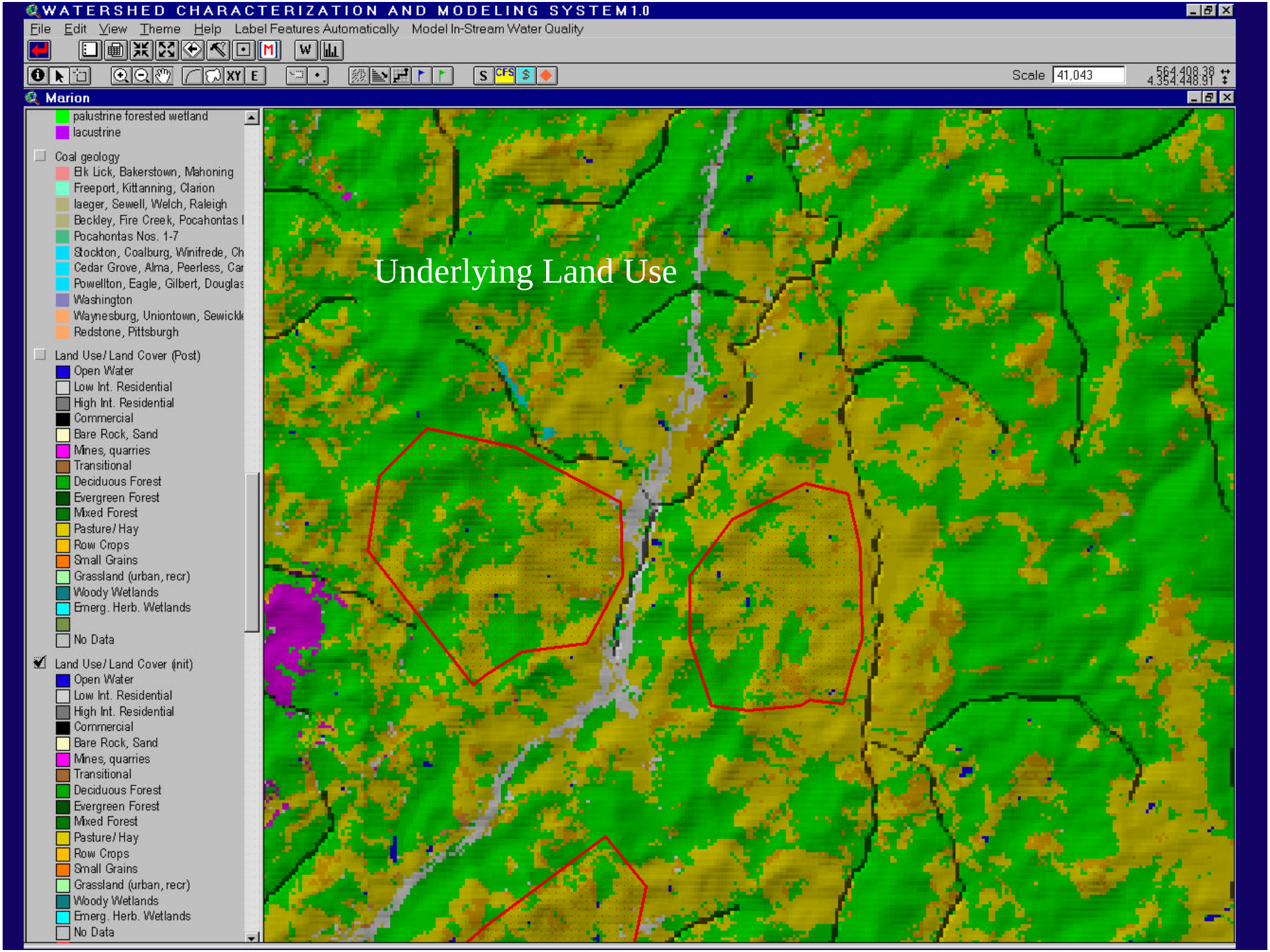
Developable Land in Ecologically Poor Condition

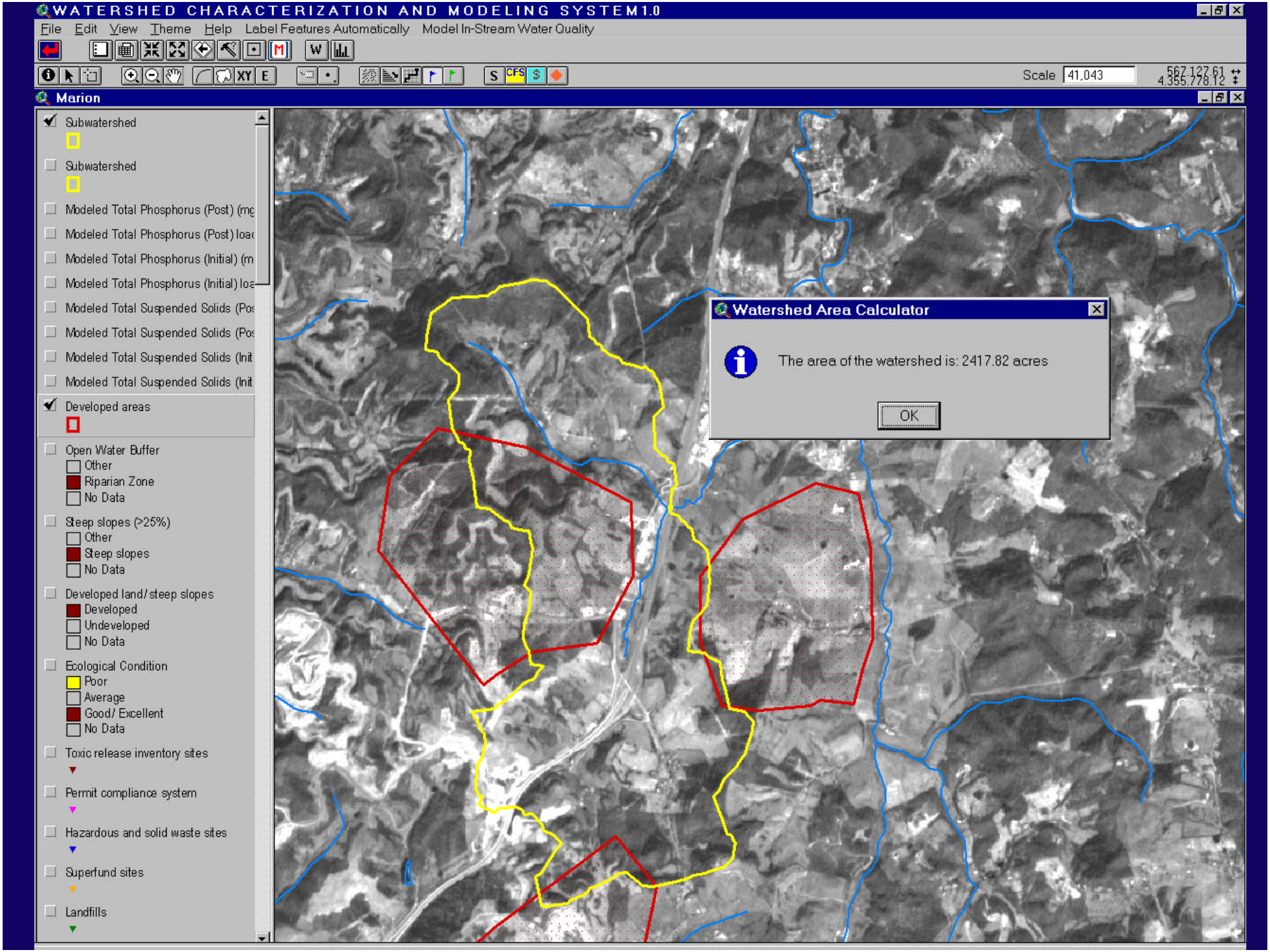


Development Potential

- Undevelopable
- Developable
- Developable and Ecologically Poor


WATERSHED CHARACTERIZATION AND MODELING SYSTEM 1.0
File Edit View Theme Help Label Features Automatically Model In-Stream Water Quality
Scale 41,043
566,328.35
4,359,600.67
Marion
Developed areas
Open Water Buffer
Other
Riparian Zone
No Data
Steep slopes (>25%)
Other
Steep slopes
No Data
Developed land/steep slopes
Developed
Undeveloped
No Data
Ecological Condition
Poor
Average
Good/ Excellent
No Data
Toxic release inventory sites
Permit compliance system
Hazardous and solid waste sites
Superfund sites
Landfills
Cities
USGS gauging stations
Public wells
Watershed border
County lines
Hypothetical Development


WATERSHED CHARACTERIZATION AND MODELING SYSTEM1.0
File Edit View Theme Help Label Features Automatically Model In-Stream Water Quality
Scale 41,043
564,408.38
4,354,448.91
Marion
palustrine forested wetland
lacustrine
Coal geology
Elk Lick, Bakerstown, Mahoning
Freeport, Kittanning, Clarion
Ieager, Sewell, Welch, Raleigh
Beckley, Fire Creek, Pocahontas
Pocahontas Nos. 1-7
Stockton, Coalburg, Winifrede, Ch
Cedar Grove, Alma, Peerless, Car
Powellton, Eagle, Gilbert, Douglas
Washington
Waynesburg, Uniontown, Sewickle
Redstone, Pittsburgh
Land Use/Land Cover (Post)
Open Water
Low Int. Residential
High Int. Residential
Commercial
Bare Rock, Sand
Mines, quarries
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Pasture/Hay
Row Crops
Small Grains
Grassland (urban, recr)
Woody Wetlands
Emerg. Herb. Wetlands
No Data
Land Use/Land Cover (Init)
Open Water
Low Int. Residential
High Int. Residential
Commercial
Bare Rock, Sand
Mines, quarries
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Pasture/Hay
Row Crops
Small Grains
Grassland (urban, recr)
Woody Wetlands
Emerg. Herb. Wetlands
No Data
Underlying Land Use


WATERSHED CHARACTERIZATION AND MODELING SYSTEM1.0
File Edit View Theme Help Label Features Automatically Model In-Stream Water Quality
Scale 41,043
567,127.61
4,355,778.12
Marion
Subwatershed
Subwatershed
Modeled Total Phosphorus (Post) (mg
Modeled Total Phosphorus (Post) loac
Modeled Total Phosphorus (Initial) (m
Modeled Total Phosphorus (Initial) los
Modeled Total Suspended Solids (Pos
Modeled Total Suspended Solids (Pos
Modeled Total Suspended Solids (Init
Modeled Total Suspended Solids (Init
Developed areas
Open Water Buffer
Other
Riparian Zone
No Data
Steep slopes (>25%)
Other
Steep slopes
No Data
Developed land/steep slopes
Developed
Undeveloped
No Data
Ecological Condition
Poor
Average
Good/ Excellent
No Data
Toxic release inventory sites
Permit compliance system
Hazardous and solid waste sites
Superfund sites
Landfills
Watershed Area Calculator
The area of the watershed is: 2417.82 acres
OK

WATERSHED CHARACTERIZATION AND MODELING SYSTEM1.0
File Edit View Theme Help Label Features Automatically Model In-Stream Water Quality
Scale 41,043
Marion
Water Quality Modeling
Modeled Total Phosphorus (Post) (mg
Modeled Total Phosphorus (Post) loa
Modeled Total Phosphorus (Initial) (m
Modeled Total Phosphorus (Initial) loa
Modeled Total Suspended Solids (Pos
Modeled Total Suspended Solids (Pos
Modeled Total Suspended Solids (Init
Modeled Total Suspended Solids (Init
Developed areas
Open Water Buffer
Other
Riparian Zone
No Data
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Steep slopes
No Data
Developed land/steep slopes
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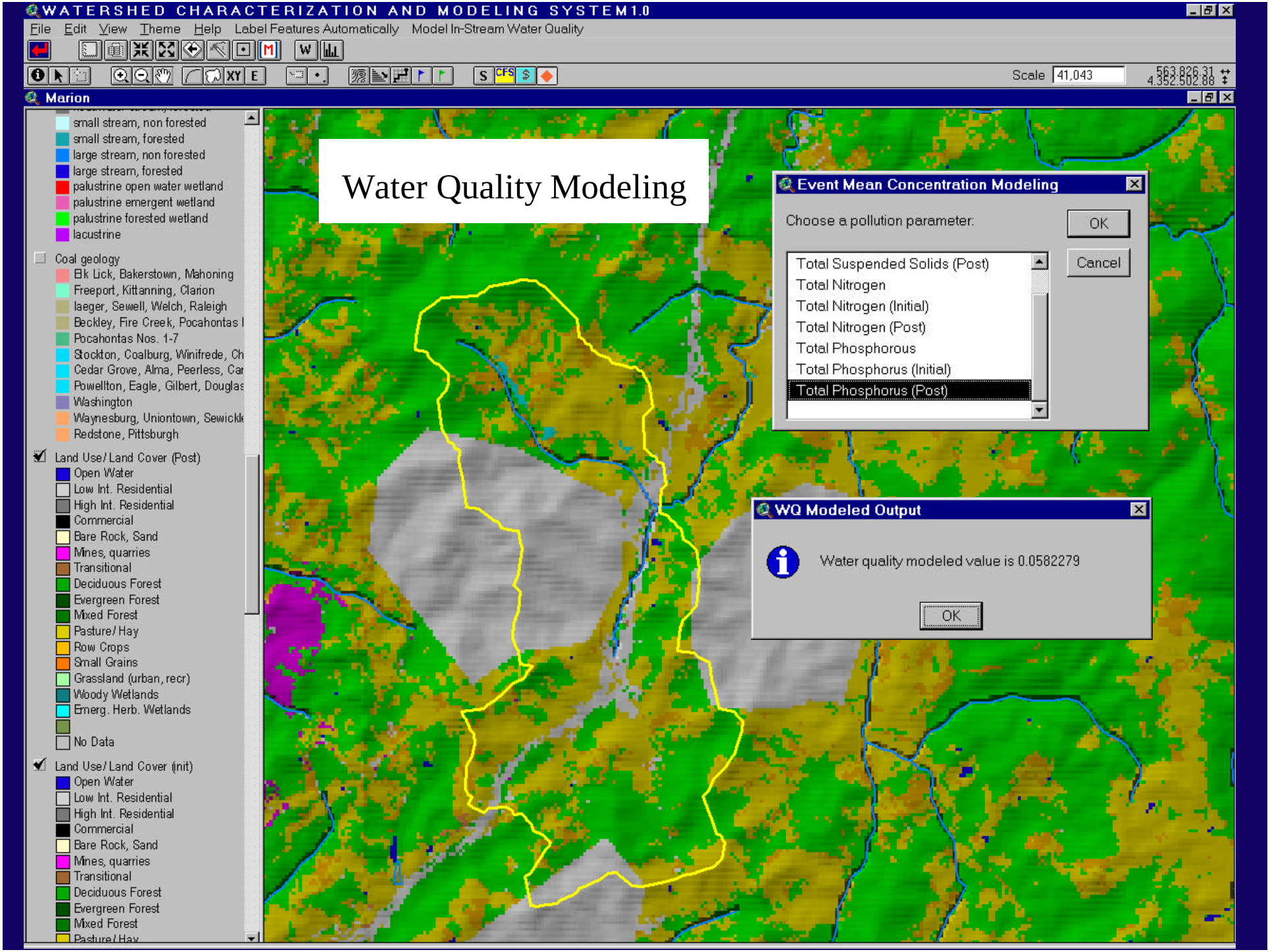
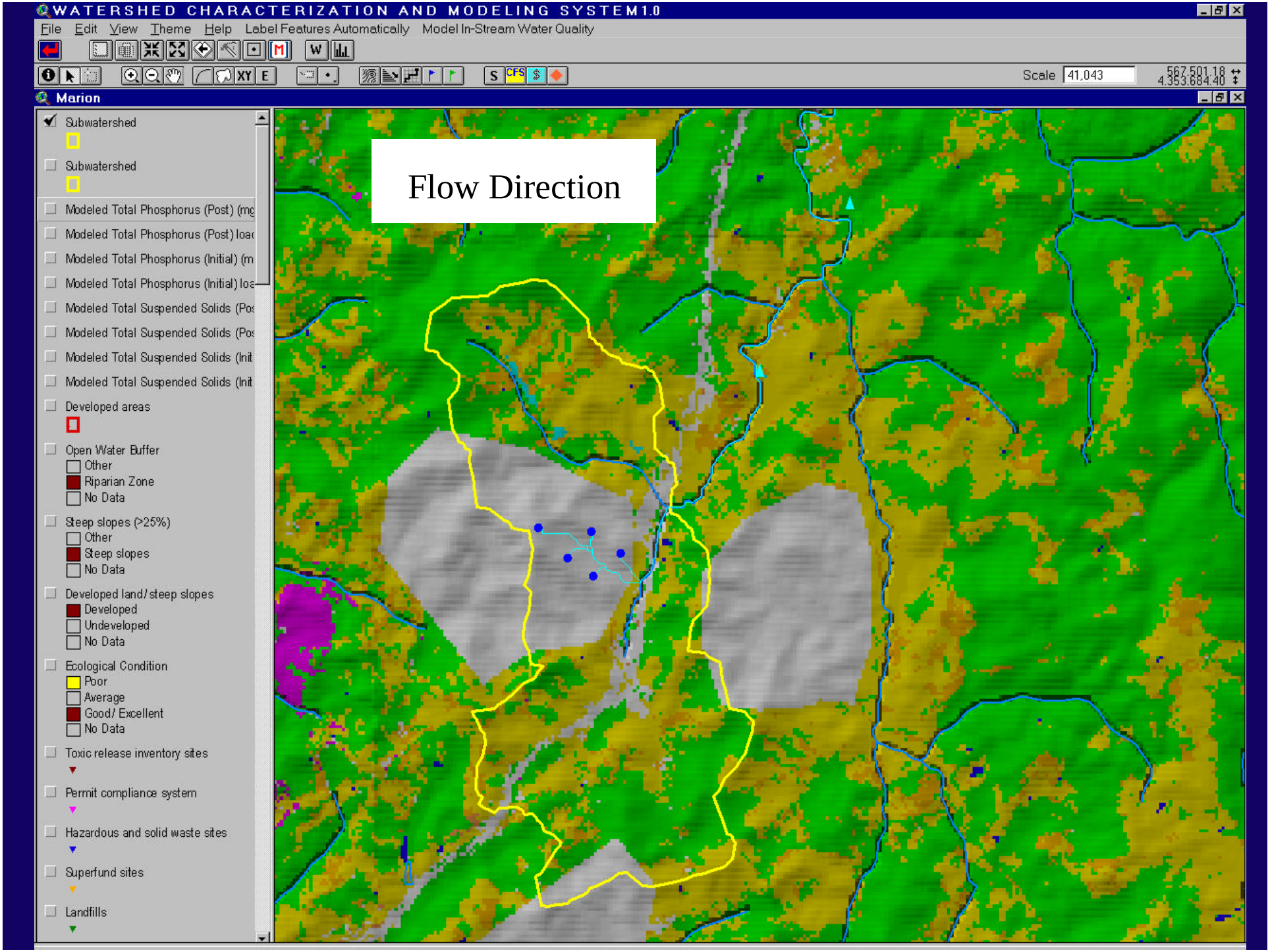
Average
Good/ Excellent
No Data
Toxic release inventory sites
Permit compliance system
Hazardous and solid waste sites
Superfund sites
Landfills
Cities
USGS gauging stations
Event Mean Concentration Modeling
Choose a pollution parameter:
OK
Cancel
Total Suspended Solids
Total Suspended Solids (Initial)
Total Suspended Solids (Post)
Total Nitrogen
Total Nitrogen (Initial)
Total Nitrogen (Post)
Total Phosphorous
Total Phosphorus (Initial)
WQ Modeled Output
Water quality modeled value is 91.7079
OK


WATERSHED CHARACTERIZATION AND MODELING SYSTEM1.0
File Edit View Theme Help Label Features Automatically Model In-Stream Water Quality
Scale 41,043
Marion
small stream, non forested
small stream, forested
large stream, non forested
large stream, forested
palustrine open water wetland
palustrine emergent wetland
palustrine forested wetland
lacustrine
Coal geology
Elk Lick, Bakerstown, Mahoning
Freeport, Kittanning, Clarion
Washington
Redstone, Pittsburgh
Land Use/ Land Cover (Post)
Open Water
Low Int. Residential
High Int. Residential
Commercial
Bare Rock, Sand
Mines, quarries
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Pasture/ Hay
Row Crops
Small Grains
Grassland (urban, recr)
Woody Wetlands
Emerg. Herb. Wetlands
No Data
Land Use/ Land Cover (init)
Open Water
Low Int. Residential
High Int. Residential
Commercial
Bare Rock, Sand
Mines, quarries
Transitional
Deciduous Forest
Evergreen Forest
Mixed Forest
Water Quality Modeling
Event Mean Concentration Modeling
Choose a pollution parameter:
OK
Cancel
Total Suspended Solids (Post)
Total Nitrogen
Total Nitrogen (Initial)
Total Nitrogen (Post)
Total Phosphorous
Total Phosphorus (Initial)
Total Phosphorus (Post)
WQ Modeled Output
Water quality modeled value is 0.0582279
OK


WATERSHED CHARACTERIZATION AND MODELING SYSTEM1.0
File Edit View Theme Help Label Features Automatically Model In-Stream Water Quality
Scale 41,043
567,501.18
4,353,684.40
Marion
Subwatershed
Subwatershed
Modeled Total Phosphorus (Post) (mg
Modeled Total Phosphorus (Post) loac
Modeled Total Phosphorus (Initial) (m
Modeled Total Phosphorus (Initial) los
Modeled Total Suspended Solids (Pos
Modeled Total Suspended Solids (Pos
Modeled Total Suspended Solids (Init
Modeled Total Suspended Solids (Init
Developed areas
Open Water Buffer
Other
Riparian Zone
No Data
Steep slopes (>25%)
Other
Steep slopes
No Data
Developed land/steep slopes
Developed
Undeveloped
No Data
Ecological Condition
Poor
Average
Good/ Excellent
No Data
Toxic release inventory sites
Permit compliance system
Hazardous and solid waste sites
Superfund sites
Landfills
Flow Direction

CVI Decision Process

Knowledge Base

Watershed Profile

Identify problems & assessment endpoints

Describe Environmental & Socio-Economic Setting

Implement & evaluate selected solutions

Canaan Valley Institute

MAIA

EMAP

Human Ecology

ReVA

Knowledge base

Community Capacity

Social

Equity

Identify & evaluate current and future stressors, risks, opportunities

Develop & select alternative solutions

Identify related human activities

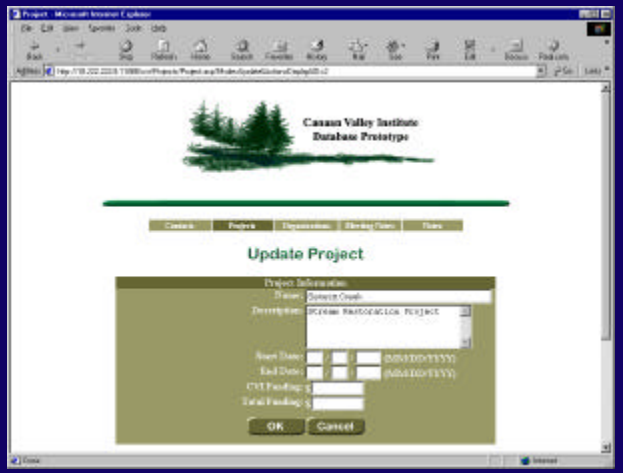
Landscape Analyst

Socio-econ/env

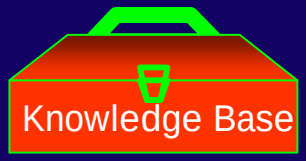
Implement sustainable solutions

CVI's Institutional Knowledge Base

CVI Actions



Interactive Mapping



Implement & evaluate selected solutions